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Biodynamic Assessment of the THOR-K Manikin

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NOTICE AND SIGNATURE PAGE

AFRL-RH-WP-TR-2013-0128 HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION IN ACCORDANCE WITH ASSIGNED DISTRIBUTION STATEMENT.

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14. ABSTRACT

A total of 39 impact tests were conducted to support a test program to evaluate the THOR-K manikin's biodynamic response for potential use in the development of advanced occupant seating systems by NASA and the USAF. The principle objective of this evaluation was to determine the biodynamic response of the THOR-K with particular emphasis on measuring the spinal and restraint harness loading for various impact orientations and loading conditions. This data would also be compared to the Hybrid III 50th percentile manikin response data in select test configurations. Testing was completed in three impact orientations: +z-axis, +y-axis, and –x-axis, and with input accelerations at various impact G-levels that ranged from 8 to 20 G peak value. Testing was also completed to determine the frequency response of the THOR-K manikin by varying the time-to-peak G of the applied input acceleration from 30 ms to 100 ms. In general, the THOR-K provided good linear response across the various test conditions out to a 20 G input acceleration for the measured test parameters evaluated. The THOR-K response was maximized at the 30 ms time-to-peak input condition. The THOR-K responded in a similar fashion to the Hybrid III manikin in terms of peak values with the exception of the head and neck responses which were consistently lower regardless of peak input acceleration or the input acceleration's time-to-peak value.

15. SUBJECT TERMS
THOR-K, Hybrid III, manikin, biodynamics, impact response, linearity, frequency response

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1.0 OVERVIEW

The Aerospace Biodynamics and Performance Group under the Aerospace Physiology and Performance Section, 711 Human Performance Wing (711 HPW/RHCPT) and their in-house technical support contractor, Infoscitex, conducted a test program to evaluate the biodynamic response of the Test Device for Human Occupant Restraint with Mod Kit or THOR-K manikin for potential use in the development of advanced occupant seating systems. The principle objective of this evaluation was to determine the biodynamic response of the THOR-K with particular emphasis on measuring the spinal and restraint harness loading for various impact orientations and loading conditions, and to determine the linearity of response parameters as a function of input acceleration level. This data would also be compared to the Hybrid III 50th percentile manikin response data in select test configurations. Testing was completed in three impact orientations: +z-axis, +y-axis, and –x-axis. Select impact conditions will also compare manikin biodynamic response data to previously collected human volunteer subject biodynamic response data under similar test conditions.

2.0 BACKGROUND

The United States of America intends to send a new generation of astronauts into space early in the next decade aboard NASA's Multi-Purpose Crew Vehicle (MPCV) which was formerly known as the Orion Crew Exploration Vehicle (CEV). The MPCV will be similar in shape to the Project Apollo crew module but significantly larger. The MPCV module will have approximately two and a half times the volume of the Apollo crew module. The larger size of the MPCV will accommodate up to four astronauts on missions to the International Space Station and possibly beyond.

After completing a space mission, the MPCV will re-enter Earth's atmosphere and the current plan will have it deploy parachutes to decelerate its descent before landing in water near the coast. An emergency abort during launch of the MPCV will be accomplished by a rocket-propelled system atop the crew module that will pull the module and its crew safely away from the primary earth-to-orbit rocket. Short duration acceleration (less than 2 sec) will occur during the abort rocket operation and then during recovery parachute operation and module landing. During normal operations the impact is not expected to exceed 10 G. In off-nominal landings, where one of the recovery parachutes has failed to deploy, the landing impact is not expected to exceed 20 G.

One plan for assessing crew member's injuries during MPCV landings was to use the Hybrid III FE manikin. The crew member response will be obtained by loading the manikin with landing load acceleration obtained from vehicle landing simulations which are currently performed using LS-Dyna. The landing load accelerations, which are combinations of X, Y, and Z accelerations, will be applied to LS-Dyna models consisting of the Hybrid III FE models placed in the MPCV seat designs. Injury criteria will be extracted from the simulations (e.g. neck forces, head accelerations, pelvic motion) and compared against the recommended injury criteria established in the HSIR requirements. An issue related to the above approach was that the Hybrid III is normally not used, nor is it validated, for dynamic multi-axial impacts. While MPCV landings generally produce primarily rear and spinal direction loading, there are landing conditions,

particularly when vehicle roll is prevalent, where a multi-axial (including lateral impact loading) impact loading occurs.

NASA and the Air Force Research Laboratory previously completed a collaborative evaluation of the Hybrid III 50th % test manikin to support the evaluation of the numerical models intended to simulate the impact responses of the test manikin. Analysis of these tests revealed several results that require additional investigation if the test manikin and numerical models are to be useful to evaluate impacts when the impact vectors are other than the forward-facing direction (–x axis). First, the loads measured at the shoulder were exceptional high. In part, the high loads have been attributed to the mechanical properties of the Hybrid III manikin shoulder. The Hybrid III is not used by the auto industry to evaluate the likelihood of injury from a multi-axial or sideward impact (y axis). An additional collaborative evaluation of a special manikin referred to as the EuroSID manikin, which is typically used for side impact loading scenarios, was also previously completed to evaluate the sideward impact forces occurring at the crew seat occupant's shoulder and hip. However, even though the side impact manikin such as the EuroSID is useful for primarely lateral loading, the Orion loading is multi-axial and the EuroSID would not be amenable for use in the LS-Dyna approach described above.

As a result, NASA and the Air Force Research Laboratory (AFRL) developed a collaborative program in conjunction with the National Highway Traffic Safety Administration (NHTSA) Vehicle Research Test Center to assess the biodynamics of the THOR-K Anthropomorphic Test Device (ATD) relative to possible impact conditions predicted for the MPCV. The THOR-K is a highly specialized instrumented manikin with a specially designed spine, shoulders, and neck to collect biodynamic response data in the three orthogonal impact axes. Previous work on various THOR manikin configurations by Littell, et al, Shaw, et al, Yoganandan, et al, and Pintar, et al, focused on the THOR response in limited tests in a single axis. The AFRL collaborative program conducted extensive impact tests on the THOR in each of the three primary axis.

The AFRL collaboration conducted impact tests of both the THOR-K and a Hybrid III 50th % manikin (for data comparison) on the 711 HPW Horizontal Impact Accelerator (HIA) using a generic seat instrumented to measure reaction forces in + z, - x, and +y impact axes. Measurements of reaction forces, moments, displacements and accelerations were made within the ATD as well. The ultimate goal is to use the collected data for the development of a THOR manikin finite element model, and for optimization of occupant seating systems and restraint system design for the MPCV and USAF aircraft ejection seats and helicopter cargo seating.

3.0 OBJECTIVES

The primary objective of this effort was to evaluate the biodynamic response of the THOR-K manikin when exposed to variable input peak acceleration and input time-to-peak accelerations in the three orthogonal axes. Specific test objectives per impact axis were as follows:

+z-axis orientation objectives:

- Test THOR-K 50th percentile and Hybrid III 50th % manikin on the HIA to establish similar baseline test conditions enabling comparison to other manikin data sets that were previously collected

- Determine the linearity of the dynamic response as a function of peak impact acceleration for the THOR-K in the +z axis
- Determine the frequency response of the THOR-K manikin by varying the on-set rate of the applied input acceleration. Frequency response will aid in characterizing how the subsystem mechanical properties affect energy amplification or attenuation of the entire ATD system during impact. Initial efforts will evaluate the need to survey the ATD responses over three impact conditions representing changes in frequency bandwidth
- Compare the THOR-K and the Hybrid III manikin responses with historical human volunteer data collected in similar conditions. Compare the frequency responses, kinematics, and actual and estimated biodynamic responses
- Determine reproducibility of the THOR-K dynamic response in the +z axis.

-x-axis orientation objectives:

- Test THOR-K 50th percentile and Hybrid III 50^{th} % manikin on the HIA to establish similar baseline test conditions enabling comparison to other manikin data sets that were previously collected
- Determine the linearity of the dynamic response as a function of peak impact acceleration for the THOR-K in the -x axis
- Determine the frequency response of the THOR-K manikin by varying the on-set rate of the applied input acceleration. Frequency response will aid in characterizing how the subsystem mechanical properties affect energy amplification or attenuation of the entire ATD system during impact. Initial efforts will evaluate the need to survey the ATD responses over three impact conditions representing changes in frequency bandwidth
- Compare the THOR-K and the Hybrid III manikin responses with historical human volunteer data collected in similar conditions. Compare the frequency responses, kinematics, and actual and estimated biodynamic responses
- Determine the linearity of the dynamic response with impact for both manikins and volunteer subjects in the -x-axis
- Determine reproducibility of the THOR-K dynamic response in the –x-axis.

+y-axis orientation objectives:

- Test THOR-K 50th percentile and Hybrid III 50^{th} % manikin on the HIA to establish similar baseline test conditions enabling comparison to other manikin data sets that were previously collected
- Determine the linearity of the dynamic response as a function of peak impact acceleration for the THOR-K in the +y axis
- Determine the frequency response of the THOR-K manikin by varying the on-set rate of the applied input acceleration. Frequency response will aid in characterizing how the subsystem mechanical properties affect energy amplification or attenuation of the entire ATD system during impact. Initial efforts will evaluate the need to survey the ATD responses over three impact conditions representing changes in frequency bandwidth
- Compare the THOR-K and the Hybrid III manikin responses with previously collected EuroSID 2re data and historical human volunteer data collected in similar conditions. Compare the frequency response, kinematics, and actual/ estimated biodynamic response
- Determine reproducibility of the THOR-K dynamic response in the +y-axis.

4.0 TEST FACILITY AND EQUIPMENT

The test method used to evaluate the THOR-K manikin response to various impact acceleration configurations was a series of variable peak and duration impact acceleration tests using the 711 HPW Horizontal Impulse Accelerator (HIA) (Shaffer, 1976; Strzelecki, 2006). The facility was used to provide various multi-axial impact accelerations to the restrained manikin in a rigid seat.

4.1 Horizontal Impulse Accelerator

The 711 HPW/RH Horizontal Impulse Accelerator (HIA) located in Bldg 824, WPAFB OH was the impact facility used for this test program. The HIA facility consists of a 4x8 ft sled positioned on a 160 ft long twin-rail track, with the sled being accelerated from a stationary position by a pneumatic actuator. The HIA actuator operates on the principle of differential gas pressures acting on both surfaces of a thrust piston in a closed 24 inch diameter cylinder. The impact acceleration occurs at the beginning of the experiment as stored high-pressure air is allowed to impinge on the back-side surface of the thrust piston which is held in place by a lock-yoke. At t=0 sec following a count-down, the lock-yoke is released causing the high-pressure air to move the thrust piston and accelerate the sled down the track. As the sled breaks contact with the thrust piston, the sled coasts to a stop or is stopped with a pneumatic brake system mounted beneath the sled.

4.2 HIA Sled Configuration

Specially designed test hardware was used for this impact program and included the multi-axial, high-G test buck which consisted of a generic flat seat pan /seat back fixture with added leg support fixture and optional side support fixture (used in previous NASA sponsored test programs). The high-G test buck allowed impact of a manikin in each of the three orthogonal axes, or a combination thereof. Two seat configurations were used and were referred to as the Generic Baseline 2 seat and the Baseline 2+S seat. The Baseline 2 seat was used in the previous study by Perry and Brinkley in 2007 supporting manikin testing for NASA. The Baseline 2+S seat had the same rigid backrest, a rigid seat pan, a rigid footrest and leg support panel, but also provided side supports that restrict the motion of the head, shoulders, hips and legs during the lateral impact conditions. The angle between the rigid back rest and rigid seat pan was set at 90° for both seat configurations. The angle between the rigid seat pan and the conditions with lower leg support panel was also set at 90°. Provisions were also provided to tether/restrain the manikin's hands and feet to designated attachment points on the seat structure and footrest as directed by the test conductor. The HIA with manikin and seat set-up for an each impact condition is shown below in Figures 1-3. The positive axis of the coordinate system for each configuration is defined with respect to the seated manikin, and is shown for each orthogonal test configuration in the figures below.

Figure 1: HIA Facility Set-up for +Z-axis Impact Test

Figure 2a and 2b: HIA Facility Set-up for Lateral +Y-axis Impact Test

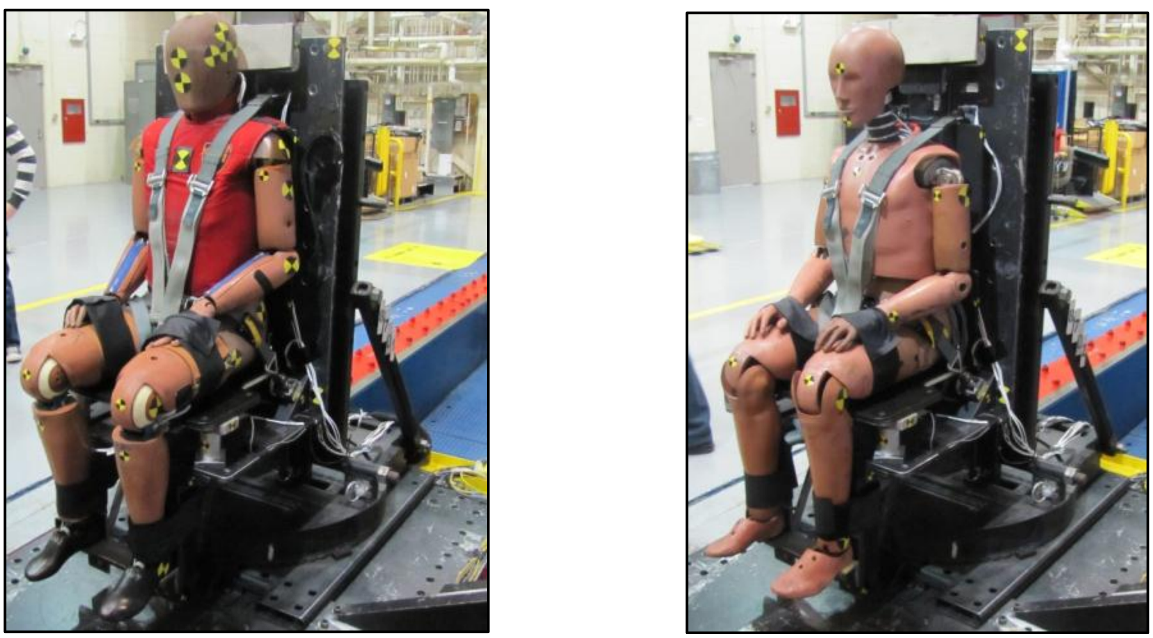
Figure 3: HIA Facility Set-up for –X-axis Impact Test

The HIA sled, as shown in Figure's 1, 2a, 2b, and 3, shows the variability of the high-G test buck to allow for the required impact configurations. Figures 2a and 2b show the additional side plates and support fixtures required during the lateral impact tests. For a point of reference, the HIA thrust column is on the right side of the figure in Figure 1, and is shown in contact with the sled prior to initiation of the pulse. For Figure 2a, 2b, and 3, the thrust column is on the left side of the figure, and is also in contact with sled prior to initiation of the pulse.

4.3 Manikins

A 50th percentile Hybrid III manikin was also used for impact testing in addition to the THOR-K manikin. The Hybrid III manikin was owned by the 711 HPW, and weighed approximately 164 lbs. The THOR-K manikin was loaned for use from the National Highway Traffic Safety Administration Vehicle Research and Test Center (NHTSA/VRTC), East Liberty OH, through an Interagency Agreement between NHTSA and NASA. The THOR-K manikin weighed approximately 174 lbs. Each manikin was tested in a baseline configuration which had them wearing no cotton thermal long underwear, although the THOR-K did wear a protective upper torso bib. No flight suits, flight harnesses, or shoes were used in any of the tests.

The manikin’s hands and lower legs were restrained to the upper legs and lower seat fixture respectively with Velcro straps to limit unwanted arm and leg kinematics which could potentially damage the manikin. This configuration also allowed for comparison of the manikin’s biodynamic response to human subject biodynamic response under similar test conditions since all human testing incorporates arm and leg restraints for safety. The manikins are shown below in Figures 4a and 4b.



a b

Figure 4. THOR-K (a) and Hybrid III 50th (b) Manikins Used During Impact Testing

4.4 Restraint

The restraint configuration used for all tests in all impact configurations consisted of a five-point restraint system that was composed of two shoulder straps, a lap belt, and a negative-g strap. Each strap consisted of 2 inch wide nylon webbing with individual adjustors. The shoulder belt restraints were a modified MB-6 shoulder harness to allow individual shoulder straps to

terminate into a right and left load cell. The lap belt restraints were a modified HBU-12/A with H Koch and Sons adjustors, and a chrome lift-style latch center connector to allow termination points for the individual shoulder straps and the crotch strap. The end fitting for each strap was designed to allow termination at a 3-axis load cell. The restraint configurations can be viewed in Figure's 5, 6 and 7.

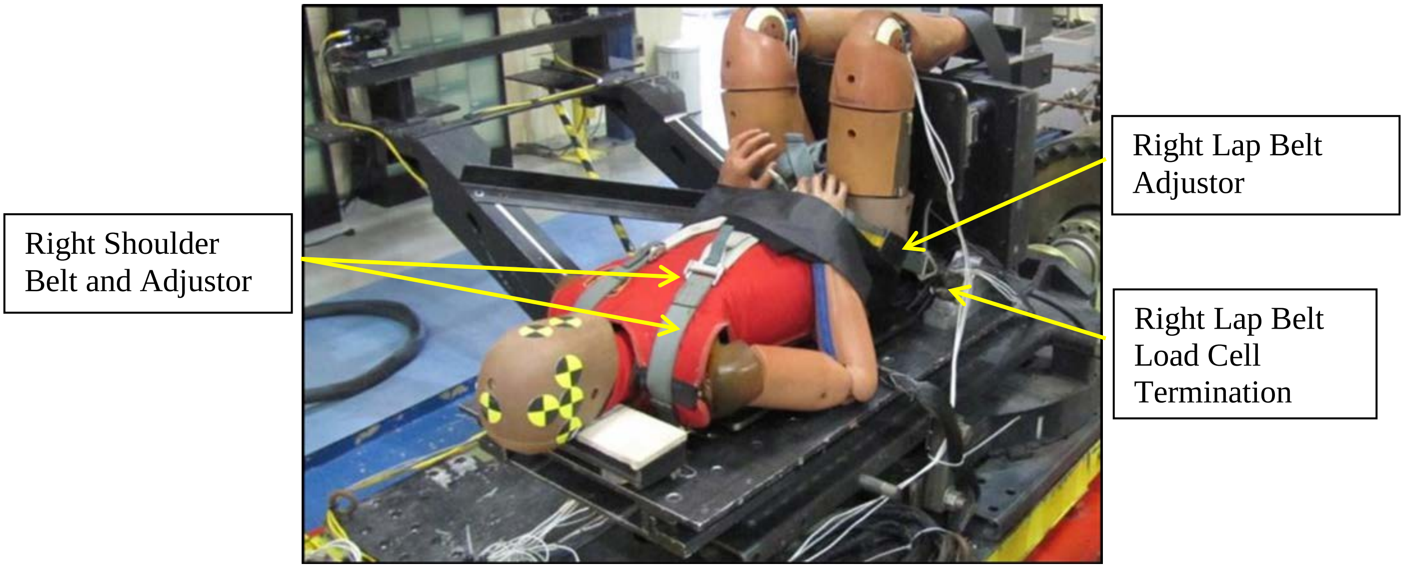


Figure 5. View of Shoulder and Lap Belts in +Z-Axis Impact Configuration

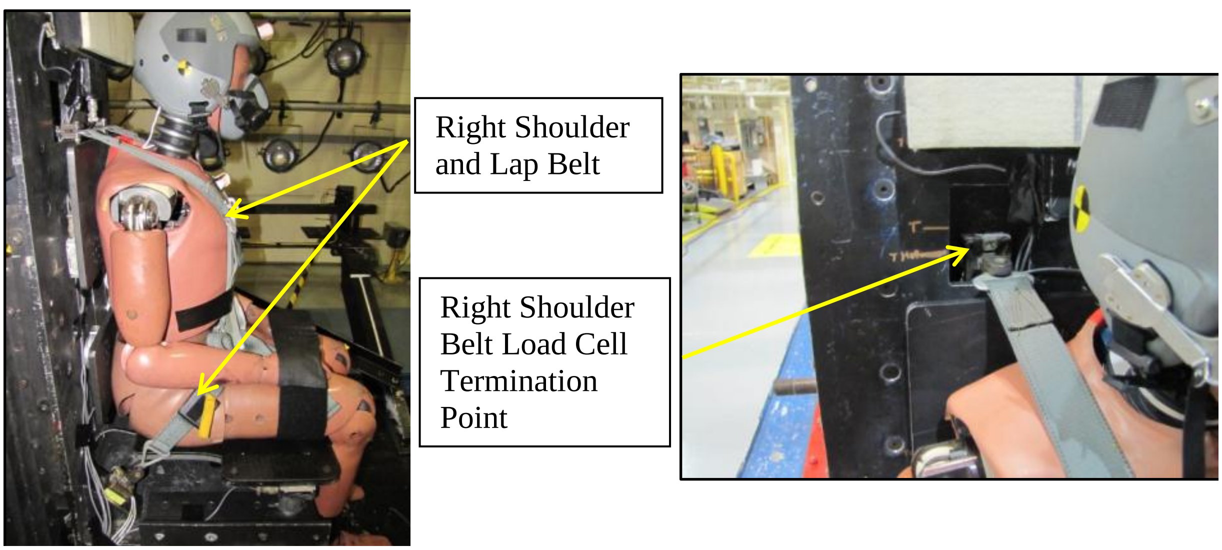


Figure 6. View of Shoulder and Lap Belts in – X-Axis Impact Configuration

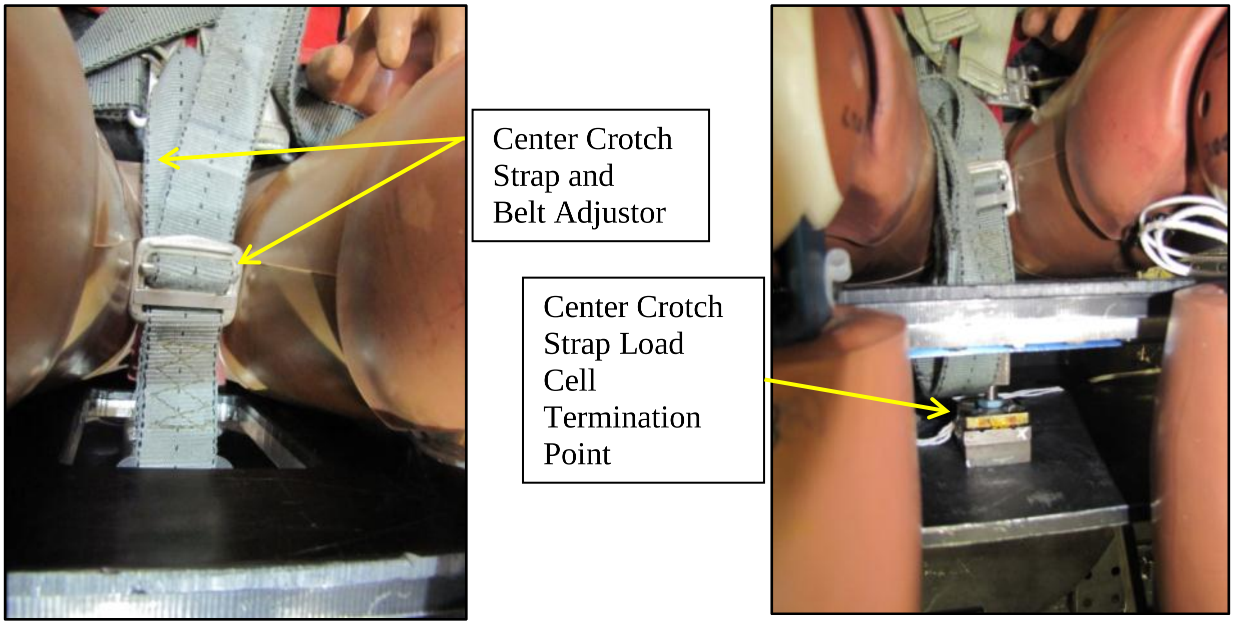


Figure 7. View of Center Crotch Strap and Load cell Termination Point

5.0 INSTRUMENTATION AND DATA COLLECTION

Transducers were chosen to provide the optimum resolution over the expected test acceleration and load ranges. Full-scale data ranges were selected to provide the expected full-scale range plus 50% to assure the capture of peak signals. All transducer bridges were balanced for optimum output prior to the start of the program. The appropriate accelerometers were adjusted with software for the effect of gravity by adding the component of a 1 G vector in-line with the force of gravity along the accelerometer axis.

The accelerometer and load transducer coordinate systems for the HIA seat fixture in the three orthogonal orientations are shown in Figure's 1 through 3. The coordinate system is right-hand rule with the z-axis parallel to the spine of the manikin or the seat back, and with positive being up towards the head of the manikin. The x-axis is perpendicular to the z-axis and points outward away from the chest of the manikin or the face of the seat fixture. The y-axis is perpendicular to the x- and z-axes according to the right-hand rule. The manikin coordinate system used was an inverted SAE J211 system (The moments were reverse from the SAE J211 system). Flexion (head rotation forward) was measured as positive, and extension (head rotation rearward) was measured as negative. Compression on the neck load cell and the lumbar load cell was positive, and tension was negative. Shear forces in the eyes-out direction were negative.

The linear accelerometers were wired to provide a positive output voltage when the acceleration experienced by the accelerometer was applied in the +x, +y and +z directions. The load cells were wired to provide a positive output voltage when the force exerted by the load cell on the subject was applied in the +x, +y or +z direction. The angular accelerometers were wired to

provide a positive output voltage when the angular acceleration experienced by the sensor was applied in the +y direction according to the right-hand rule.

5.1 Facility Instrumentation

The HIA test sled was instrumented with a single linear accelerometer mounted beneath the sled deck on a rigid support beam. An Endevco Model 2262a-200 accelerometer was installed to measure acceleration in the sled x-axis. The sled's velocity was measured using a Globe Industries Model 22A672-2 velocity sensor mounted on the side of the sled.

The specially fabricated test fixture was instrumented with both single axis and 3-axis load cells to measure the reaction load into the seat and the restraint harness. Twelve single axis load cells, Model Strainsert FL2.5-2SPKT, were mounted to record the loads at the following force plates: 3 load cells at the headrest plate; 3 load cells at the upper seat back plate; 3 load cells at the lower back plate; and 3 load cells in the seat pan. The lateral impact tests added four load plates which were all instrumented with single axis load cells, Model Strainsert FL2.5-2SPKT, and identified as right headrest plate, right shoulder plate, right pelvis plate, and right knee plate.

Four 3-axis load cells, Model Michigan Scientific 4000, were mounted to record the manikin's reaction loads into the restraint configuration at the following restraint termination points: upper left shoulder, upper right shoulder, lower left lap belt, and lower right lap belt. A fifth 3-axis load cell, Model Michigan Scientific 3000, was mounted below the seat pan to record the manikin's reaction loads into the restraint configuration termination point of the center crotch belt.

5.2 Manikin Instrumentation

The THOR-K and the Hybrid III Aerospace manikins are both 50th percentile manikins and were instrumented with load cells and accelerometers to define their biodynamic response (instrumentation is detailed in following section). The test manikins were instrumented sufficiently to provide reliable data collection over the time domain and load application durations as specified by the test matrix. Force measurements were taken internally to the manikin at locations long the neck and spine (axial loads, shear loads, and torques). Acceleration measurements were also taken internal to the manikin (angular rates of the head and tri-axial linear accelerations of the head, chest, and pelvis).

The Hybrid III Aerospace manikin has an articulated pelvis and a straight lumbar spine segment which is different from the Hybrid III Automotive manikin (fixed pelvis, curved spine segment). The manikins were not dressed in a flight suit for these tests as previously indicated, but were tested in select test cells with a HGU-55/P helmet to allow comparisons to previous human test data in which the subjects wore a helmet. A MBU-20/P mask was added to the helmet to provide a similar weighted helmet configuration as that used during the human tests.

The Hybrid III manikin had typical accelerometer and load cell instrumentation. The head was instrumented with a tri-axial arrangement of Endevco Model 7264C-500 linear accelerometers,

and with a single Endevco Model 7302B angular accelerometer mounted to record head acceleration around the head y-axis. The chest was instrumented with a tri-axial arrangement of Endevco Model 7264C-500 linear accelerometers. The lower lumbar/pelvis was instrumented with a single tri-axial accelerometer, Entran Model EGV3-F-250. The upper neck joint was instrumented with a 6-channel Denton Model 1716A load cell to measure linear forces and rotational torques in the three orthogonal axes. The lower neck joint was instrumented with a 6-channel Denton Model 1794A-JTF load cell to measure linear forces and rotational torques in the three orthogonal axes. The junction of the lumbar spine and pelvis was instrumented with a 6-channel Denton Model 1714A load cell to measure linear forces and rotational torques in the three orthogonal axes.

The THOR-K manikin had very specialized instrumentation through-out. The head was instrumented with a tri-axial arrangement of Endevco Model 7264C-2K linear accelerometers, and with a tri-axial arrangement of DTS Model ARS PRO-18K angular rate sensors mounted to record head rotational velocity around the head's three orthogonal axes. The anterior chest (sternum) was instrumented with a single Endevco Model 7264C-2K linear accelerometer to record acceleration in the x-axis. The posterior chest (at level of T6 spinal segment) was instrumented with a tri-axial arrangement of Endevco Model 7264C-2K linear accelerometers. The upper and lower thoracic spine (at level T1 and T12 spinal segments respectively) and the pelvis were each instrumented with a tri-axial arrangement of Endevco Model 7264C-2K; however, one of the accelerometers in the upper tri-axial arrangement was an Entran Model EGEB6Q-2000. The upper neck joint was instrumented with a 6-channel Denton Model 3454J load cell to measure linear forces and rotational torques in the three orthogonal axes. The lower neck joint was instrumented with a 6-channel Denton Model 4366J load cell to measure linear forces and rotational torques in the three orthogonal axes. The THOR-K neck also utilized special front and rear springs that were instrumented with a Denton Model 6005J single axis load cell. The occipital condyle (head and neck joint) was instrumented with a SFERENICE Model 50ESC angular displacement sensor. The thoracic/lumbar spine junction was instrumented with a 6-channel Humanetics Model 1911A load cell to measure linear forces and rotational torques in the three orthogonal axes. The right and left clavicles were each instrumented with two single axis Humanetics Model 9590J load cells to measure linear forces in the x- and z-axis. The right acetabular joint (at location of femoral head) in the pelvis was instrumented with a 3-channel Humanetics Model 3455J load cell to measure reaction loads in the three orthogonal axes.

The pre-impact positions of special internal position sensors in the torso of the THOR-K were collected prior to each test with respect to the seat to document the initial condition/location of these anatomical sensor points from test to test. Data from the same sensors were also collected post-test before the sled was pulled back to its start position. This data was collected with a laptop PC with special software designed for the internal position sensors. The four locations (right and left upper thorax, and right and left lower thorax) were each instrumented with two Humanetics Model 9945 angular displacement sensors, and a single Humanetics Model IF-364-C-R2-W253 linear displacement sensor. Additional sensors were also located at the right and left ankle joints with each joint instrumented with three Contelec Model PD210-4B rotational displacement sensors to measure displacement in the three orthogonal axes.

5.3 Transducer Calibration

On-site personnel from Infoscitex, Inc conducted pre- and post-calibrations on all sensors used on the sled, seat fixture, and the Hybrid III manikin. NHTSA was responsible for pre- and post-calibration on all sensors used with the THOR-K manikin. Calibration records of individual transducers as well as the Standard Practice Instructions are maintained in the biodynamic facility's Impact Information Center. For this test program, a record was made identifying the data channel, transducer manufacturer, model number, serial number, date and sensitivity of pre-calibration, date and sensitivity of post-calibration, and percentage change. Pre and post-calibration information is maintained with the program data. A record was made for the Hybrid III manikin instrumentation set-up, and a second record was made for the THOR-K instrumentation set-up. The instrumentation used in this study is listed in the two Electronic Instrumentation Data Sheets (See Attachment's 1and 2).

5.4 Data Acquisition Control

The Master Instrumentation Control Unit in the Instrumentation Station beside the HIA test facility controlled data acquisition. A test was initiated when the countdown clock reached zero using a comparator. The comparator was set to start data collection at a pre-selected time based on a positive reading of multiple safety inter-lock sensors used by the facility to protect the facility operators and human test subjects (not used for this program). Data were recorded to establish a zero reference for all transducers prior to restraining the manikin to the divan seat fixture. The reference data were stored separately from the test data and were used in the processing of the test data. A reference mark pulse was generated to mark the electronic data at a pre-selected time after test initiation to place the reference mark close to the impact point. The reference mark time was used as the start time for data processing of the electronic data.

5.5 Data Acquisition System

This program used both the TDAS Pro and the G5 data acquisition systems (DAS), manufactured by Diversified Technical Systems (DTS), Inc., to collect all the fixture and manikin data for each test as defined by the test matrix. The 64 channel TDAS Pro was used to collect the internal manikin instrumentation data for either the THOR-K or the Hybrid III manikin. The 32 channel G5 was used to collect the HIA sled and test fixture instrumentation data. The TDAS PRO and the G5 are ruggedized, DC powered, fully programmable signal conditioning and recording systems for transducers and events. The TDAS PRO and the G5 were designed to withstand a 100 G shock. The DAS units were installed at the back of the HIA sled opposite to the end of sled that contacts the HIA thrust piston (See Figure 8).

The signal conditioning accepts a variety of transducers including full and partial bridges, voltage, and piezoresistive sensors. Transducer signals are amplified, filtered, digitized and recorded in onboard solid-state memory. The data acquisition system is controlled through an Ethernet interface using the Ethernet instruction language. A desktop PC with an Ethernet board configures the TDAS PRO and G5 before testing and retrieves the data after each test. For this program, both DAS systems collected data at a 10K sample rate with a 3K anti-aliasing filter.

The electronic data was then post-processed per SAE J211and filtered as follows: 1650 Hz filter for internal head linear and angular accelerations and velocities, and internal neck axial forces; 1000 Hz filter for internal neck moments, neck spring, clavicle forces, sternum, spine, chest, and pelvis accelerations, spinal forces and moments, acetabular forces, and all seat fixture plates and restraint load cells; 600 Hz filter for internal head angle rotation, chest deflections, abdominal deflections, and ankle rotations; 100 Hz filter for HIA sled accelerations and sled velocity.

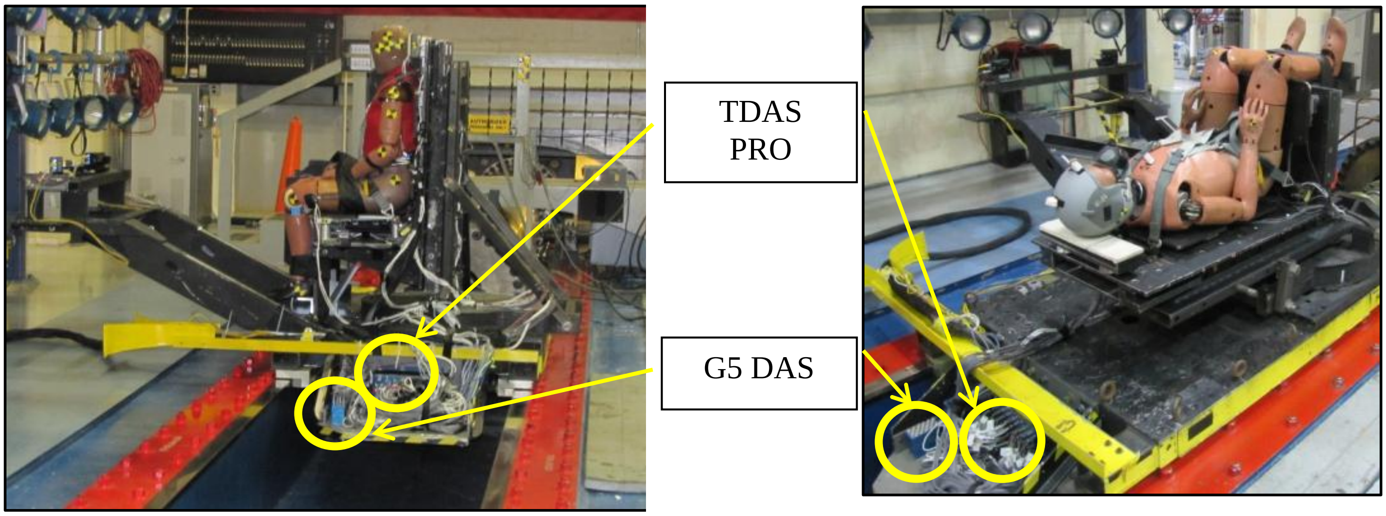


Figure 8. TDAS PRO and G5 DAS Systems Mounted on HIA Sled

5.6 Quick Look Data Plots

After each test, the filtered data were graphically plotted in a portrait format of 4-6 plots per page, and grouped with similar channels. The spreadsheet of plots also contained pertinent maxima, minima, and respective times of each occurrence. For all data, time = 0 was at initial sled motion. The plots arranged in this fashion included: displacement versus time, force (load) versus time, and acceleration versus time. This was accomplished using the "quick look" SCAN_EME routine. Examples of the quick look data plots are shown in Attachment 1.

5.7 High Speed Video and Photography

Two Phantom Micro 3 High-Speed digital cameras (Figure 9) were used to collect video and target motion data. Each camera was mounted on board the sled on a special fixture which allowed perpendicular and oblique views of the test manikin for each test (Figure 10).

The Phantom Micro line is a compact, light-weight, rugged family of cameras targeted at industrial applications ranging from biometric research to automotive crash testing. Rated to survive 100g acceleration this rugged camera can take 512x512 images at up to 2200 frames-per-second (fps). Reduce the resolution to 32 x 32 and achieve frame rates greater than 95,000 fps. With an ISO rating of 4800 (monochrome, saturation-based ISO 12232), the camera has the light sensitivity for the most demanding applications. With shutter speeds as low as 2 microseconds,

the user can freeze objects in motion, eliminate blur, and bring out the image detail needed for successful motion analysis. The camera accepts any standard 1" C-mount lens.
The Phantom Micro 3 member of the family is optimized for applications such as Hydraulically Controlled, Gas Energized (HYGE) crash simulations used in the automotive industry. Selectable 8-, 10- or 12-bit pixel depth allows the user to choose the dynamic range that best meets the demands of the application. The Miro 3 has a number of external control signals allowing for external triggering, camera synchronization, and time-stamping. The camera has both dynamic RAM and internal flash memory for non-volatile storage. Internal battery power allows the camera to be used in an un-tethered mode and ensures data survivability in case of loss of power.

The images for this study were collected at 500 frames per second (fps). The video files were downloaded and converted to AVI format, and stored in the RH Biodynamic Data Bank. Photographs were taken of the test set-up prior to each test. Photographic and video data were stored on an internal network for downloads as requested.

Figure 9. Phantom Micro 3 High-Speed Digital Camera

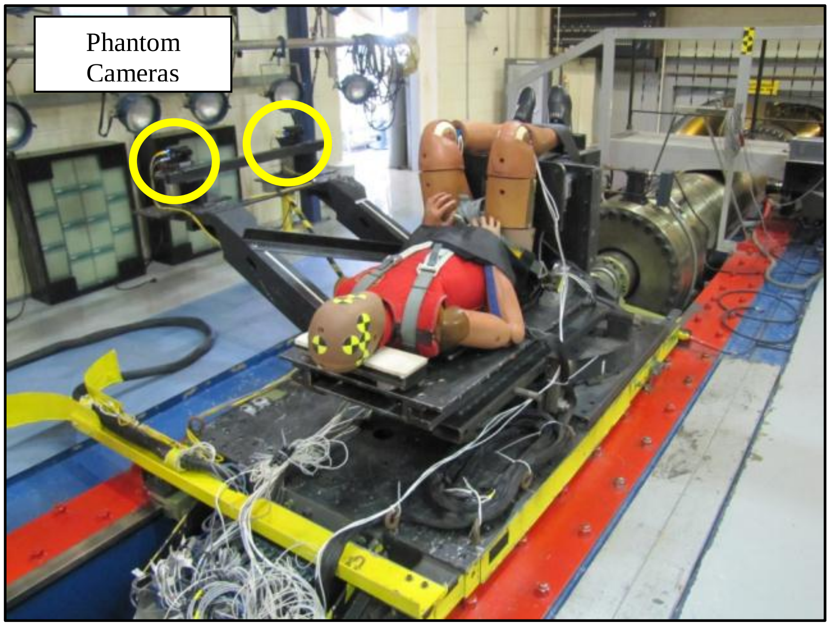


Figure 10. Phantom Micro 3 Camera Locations for THOR-K and Hybrid III Tests

6.0 EXPERIMENTAL DESIGN

Preliminary predictions of peak acceleration conditions used for this program were based on landing simulations of the ORION capsule and were 10 G nominal and 20 G off-nominal. The impacts for the this test series consisted of four different peak G-levels (8,10,12,and 20) to allow for trend analysis of the manikin's response that includes the landing simulation conditions. The HIA facility used impact pins #10, #11, and #23 which allowed for the variation of impact pulse durations of approximately 30ms, 70ms, and 100ms respectively in order to evaluate the manikin frequency response. A plot of the different pulse durations for the 10 G condition is shown in Figure 11. Multiple tests for select conditions were conducted to test the repeatability of the THOR-K manikin for modeling purposes. All of the G-levels with corresponding pin configurations are captured in the test matrix and also the test-by-test summary sheet within this report. The test matrix for this program is shown in Table 1.

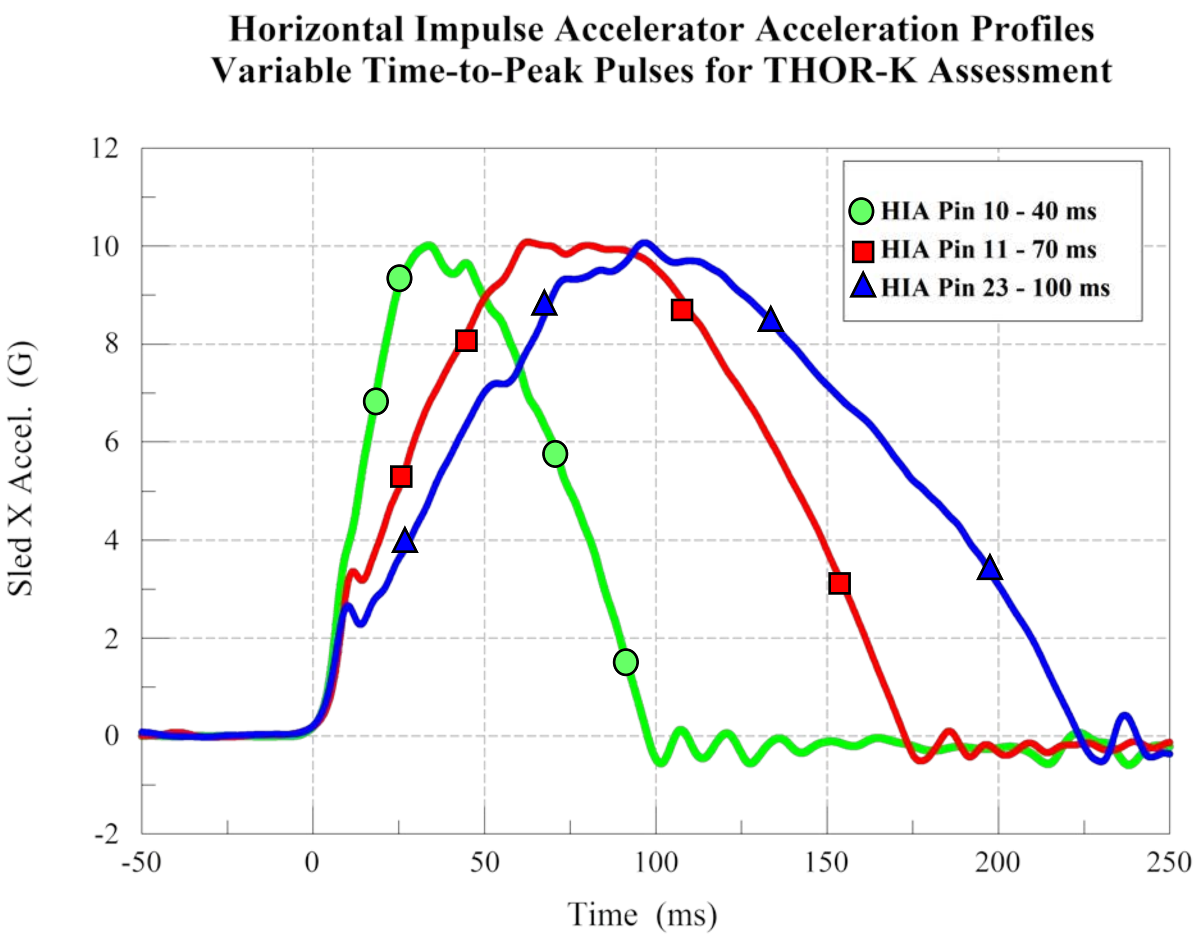


Figure 11. HIA Acceleration Profiles for Variable Time-to-Peak Input Pulses

Table 1. Test Matrix

Test Cell	Impact Vector	Impact Direction	Impact Level (G)	Rise Time (ms)	Metering Pin	Manikin Type	No. of Impacts	Helmet
A1	+Z	Spinal	10	30	10	THOR-K	2	No
A2	+Z	Spinal	10	30	10	THOR-K	1	HGU-55/P
A3	+Z	Spinal	10	30	10	H-III AERO	1	HGU-55/P
B1	Y	Lateral	10	30	10	THOR-K	2	No
B2	Y	Lateral	10	30	10	H-III AERO	1	No
C1	Y	Lateral	10	70	11	H-III AERO	1	No
C2	Y	Lateral	10	70	11	THOR-K	2	No
C3	Y	Lateral	20	70	11	THOR-K	2	No
D1	-X	Frontal	20	70	11	THOR-K	2	No
D2	-X	Frontal	10	70	11	THOR-K	2	No
D3	-X	Frontal	10	70	11	H-III AERO	1	No
D4	-X	Frontal	20	70	11	H-III AERO	1	No
E1	+Z	Spinal	10	70	11	H-III AERO	1	HGU-55/P
E2	+Z	Spinal	10	70	11	THOR-K	1	HGU-55/P
E3	+Z	Spinal	10	70	11	THOR-K	2	No
E4	+Z	Spinal	20	70	11	THOR-K	2	No
F1	+Z	Spinal	10	100	23	THOR-K	2	No
F2	+Z	Spinal	10	100	23	THOR-K	1	HGU-55/P
F3	+Z	Spinal	12	100	23	THOR-K	1	HGU-55/P
F4	+Z	Spinal	8	100	23	THOR-K	1	HGU-55/P
F5	+Z	Spinal	10	100	23	H-III AERO	1	HGU-55/P
G1	-X	Frontal	8	100	23	H-III AERO	2	HGU-55/P
G2	-X	Frontal	8	100	23	THOR-K	2	No
G3	-X	Frontal	8	100	23	THOR-K	1	HGU-55/P
G4	-X	Frontal	10	100	23	THOR-K	1	HGU-55/P
H1	Y	Lateral	10	100	23	H-III AERO	1	No
H2	Y	Lateral	10	100	23	THOR-K	2	No

7.0 RESULTS

7.1 Test-by-Test Summary

A total of 48 impact tests on the HIA were completed in support of this effort to evaluate the biodynamic response of the THOR-K manikin. The following is a review of the test configuration for each of the 48 impact tests with a test-by-test summary.

- **Test 8656**: 10 G facility proof test (Seat in z-axis impact orientation).

- **Test 8657**: 10 G facility proof test (Seat in z-axis impact orientation).

- **Test 8658**: Cell A1; HIA Pin 10; NASA baseline seat in a + z-axis impact orientation with 10 G, 30 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.01 G, Sled vel = 19.12 ft/s; **Successful Test**.

- **Test 8659**: Cell A1; HIA Pin 10; NASA baseline seat in a + z-axis impact orientation with 10 G, 30 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.97 G, Sled vel = 18.99 ft/s; **Successful Test**.

- **Test 8660**: Cell A2; HIA Pin 10; NASA baseline seat in a + z-axis impact orientation with 10 G, 30 ms rise-time input; THOR-K manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.01 G, Sled vel = 19.22 ft/s; **Successful Test**.

- **Test 8661**: Cell A3; HIA Pin 10; NASA baseline seat in a + z-axis impact orientation with 10 G, 30 ms rise-time input; Hybrid III 50^{th} % manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.95 G, Sled vel = 19.17 ft/s; **Successful Test**.

- **Test 8662**: Cell E1; HIA Pin 11; NASA baseline seat in a + z-axis impact orientation with 10 G, 70 ms rise-time input; Hybrid III 50^{th} % manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.9 G, Sled vel = 37.4 ft/s; **No Test – Target G level too high**.

- **<u>Test 8663</u>**: Cell E1; HIA Pin 11; NASA baseline seat in a + z-axis impact orientation with 10 G, 70 ms rise-time input; Hybrid III 50th % manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.52 G, Sled vel = 36.75 ft/s; **No Test – Target G level too high**.

- **<u>Test 8664</u>**: Cell E1; HIA Pin 11; NASA baseline seat in a + z-axis impact orientation with 10 G, 70 ms rise-time input; Hybrid III 50th % manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.2 G, Sled vel = 35.76 ft/s; **Successful Test**.

- **<u>Test 8665</u>**: Cell E2; HIA Pin 11; NASA baseline seat in a + z-axis impact orientation with 10 G, 70 ms rise-time input; THOR-K manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.73 G, Sled vel = 33.51 ft/s; **Successful Test**.

- **<u>Test 8666</u>**: Cell E3; HIA Pin 11; NASA baseline seat in a + z-axis impact orientation with 10 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.82 G, Sled vel = 35.77 ft/s; **Successful Test**.

- **<u>Test 8667</u>**: Cell E3; HIA Pin 11; NASA baseline seat in a + z-axis impact orientation with 10 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.08 G, Sled vel = 36.41 ft/s; **Successful Test**.

- **<u>Test 8668</u>**: Cell E4; HIA Pin 11; NASA baseline seat in a + z-axis impact orientation with 20 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 21.83 G, Sled vel = 55.45 ft/s; **Successful Test (NASA desired peak G to be close to 21 for comparison to previous testing)**.

- **<u>Test 8669</u>**: Cell E4; HIA Pin 11; NASA baseline seat in a + z-axis impact orientation with 20 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 21.44 G, Sled vel = 55.12 ft/s; **Successful Test (NASA desired peak G to be close to 21 for comparison to previous testing).**

- **<u>Test 8670</u>**: Cell F1; HIA Pin 23; NASA baseline seat in a + z-axis impact orientation with 10 G, 100 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.41 G, Sled vel = 34.18 ft/s; **No Test – Target G level too low**.

- **<u>Test 8671</u>**: Cell F1; HIA Pin 23; NASA baseline seat in a + z-axis impact orientation with 10 G, 100 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.91 G, Sled vel = 35.27 ft/s; **Successful Test**.

- **<u>Test 8672</u>**: Cell F1; HIA Pin 23; NASA baseline seat in a + z-axis impact orientation with 10 G, 100 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.93 G, Sled vel = 35.35 ft/s; **Successful Test**.

- **<u>Test 8673</u>**: Cell F2; HIA Pin 23; NASA baseline seat in a + z-axis impact orientation with 10 G, 100 ms rise-time input; THOR-K manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.97 G, Sled vel = 35.33 ft/s; **Successful Test**.

- **<u>Test 8674</u>**: Cell F3; HIA Pin 23; NASA baseline seat in a + z-axis impact orientation with 12 G, 100 ms rise-time input; THOR-K manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.93 G, Sled vel = 36.97 ft/s; **No Test – Target G level too low**.

- **<u>Test 8675</u>**: Cell F3; HIA Pin 23; NASA baseline seat in a + z-axis impact orientation with 12 G, 100 ms rise-time input; THOR-K manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 12.22 G, Sled vel = 39.62 ft/s; **Successful Test**.

- **<u>Test 8676</u>**: Cell F4; HIA Pin 23; NASA baseline seat in a + z-axis impact orientation with 8 G, 100 ms rise-time input; THOR-K manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 8.00 G, Sled vel = 31.43 ft/s; **Successful Test**.

- **<u>Test 8677</u>**: Cell F5; HIA Pin 23; NASA baseline seat in a + z-axis impact orientation with 10 G, 100 ms rise-time input; Hybrid III 50th % manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.89 G, Sled vel = 33.2 ft/s; **Successful Test**.

- **<u>Test 8678</u>**: Cell G1; HIA Pin 23; NASA baseline seat in a - x-axis impact orientation with 8 G, 100 ms rise-time input; Hybrid III 50th % manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 7.97 G, Sled vel = 29.86 ft/s; **Successful Test**.

- **<u>Test 8679</u>**: Cell G2; HIA Pin 23; NASA baseline seat in a - x-axis impact orientation with 8 G, 100 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 8.04 G, Sled vel = 29.50 ft/s; **Successful Test**.

- **<u>Test 8680</u>**: Cell G2; HIA Pin 23; NASA baseline seat in a - x-axis impact orientation with 8 G, 100 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 8.02 G, Sled vel = 29.99 ft/s; **Successful Test**.

- **<u>Test 8681</u>**: Cell G3; HIA Pin 23; NASA baseline seat in a - x-axis impact orientation with 8 G, 100 ms rise-time input; THOR-K manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 8.00 G, Sled vel = 30.00 ft/s; **Successful Test**.

- **<u>Test 8682</u>**: Cell G4; HIA Pin 23; NASA baseline seat in a - x-axis impact orientation with 10 G, 100 ms rise-time input; THOR-K manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.87 G, Sled vel = 33.69 ft/s; **Successful Test**.

- **<u>Test 8683</u>**: Cell G1; HIA Pin 23; NASA baseline seat in a - x-axis impact orientation with 8 G, 100 ms rise-time input; Hybrid III 50th % manikin; HGU-55/P helmet with mask (no hose); Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 7.93 G, Sled vel = 29.74 ft/s; **Successful Test**.

- **Test 8684**: Cell H1; HIA Pin 23; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 100 ms rise-time input; Hybrid III 50th % manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.9 G, Sled vel = 44.84 ft/s; **No Test – Target G level too high**.

- **Test 8685**: Cell H1; HIA Pin 23; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 100 ms rise-time input; Hybrid III 50th % manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.88 G, Sled vel = 42.49 ft/s; **Successful Test**.

- **Test 8686**: Cell H2; HIA Pin 23; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 100 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.20 G, Sled vel = 44.51 ft/s; **Successful Test**.

- **Test 8687**: Cell H2; HIA Pin 23; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 100 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.07 G, Sled vel = 44.13 ft/s; **Successful Test**.

- **Test 8688**: Cell B1; HIA Pin 10; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 30 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.12 G, Sled vel = 18.12 ft/s; **Successful Test**.

- **Test 8689**: Cell B1; HIA Pin 10; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 30 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.04 G, Sled vel = 18.08 ft/s; **Successful Test**.

- **Test 8690**: Cell B2; HIA Pin 10; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 30 ms rise-time input; Hybrid III 50th % manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.15 G, Sled vel = 19.23 ft/s; **Successful Test**.

- **<u>Test 8691</u>**: Cell C1; HIA Pin 11; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 70 ms rise-time input; Hybrid III 50^{th} % manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.7 G, Sled vel = 36.42 ft/s; **No Test – Target G level too high**.

- **<u>Test 8692</u>**: Cell C1; HIA Pin 11; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 70 ms rise-time input; Hybrid III 50^{th} % manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.08 G, Sled vel = 35.21 ft/s; **Successful Test**.

- **<u>Test 8693</u>**: Cell C2; HIA Pin 11; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.27 G, Sled vel = 36.52 ft/s; **Successful Test**.

- **<u>Test 8694</u>**: Cell C2; HIA Pin 11; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 10 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.05 G, Sled vel = 35.80 ft/s; **Successful Test**.

- **<u>Test 8695</u>**: Cell C3; HIA Pin 11; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 20 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 20.31 G, Sled vel = 53.67 ft/s; **Successful Test**.

- **<u>Test 8696</u>**: Cell C3; HIA Pin 11; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 20 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 20.61 G, Sled vel = 53.68 ft/s; **No Test – Target G level too high**.

- **<u>Test 8697</u>**: Cell C3; HIA Pin 11; NASA baseline seat in a + y-axis impact orientation with added side-panels and with 20 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 19.93 G, Sled vel = 53.22 ft/s; **Successful Test**.

- **<u>Test 8698</u>**: Cell D1; HIA Pin 11; NASA baseline seat in a - x-axis impact orientation and with 20 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 20.38 G, Sled vel = 53.30 ft/s; **Successful Test**.

- **<u>Test 8699</u>**: Cell D1; HIA Pin 11; NASA baseline seat in a - x-axis impact orientation and with 20 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 20.30 G, Sled vel = 51.83 ft/s; **Successful Test**.

- **<u>Test 8700</u>**: Cell D2; HIA Pin 11; NASA baseline seat in a - x-axis impact orientation and with 10 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 9.89 G, Sled vel = 34.05 ft/s; **Successful Test**.

- **<u>Test 8701</u>**: Cell D2; HIA Pin 11; NASA baseline seat in a - x-axis impact orientation and with 10 G, 70 ms rise-time input; THOR-K manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.00 G, Sled vel = 36.04 ft/s; **Successful Test**.

- **<u>Test 8702</u>**: Cell D3; HIA Pin 11; NASA baseline seat in a - x-axis impact orientation and with 10 G, 70 ms rise-time input; Hybrid III 50th % manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 10.03 G, Sled vel = 34.94 ft/s; **Successful Test**.

- **<u>Test 8703</u>**: Cell D4; HIA Pin 11; NASA baseline seat in a - x-axis impact orientation and with 20 G, 70 ms rise-time input; Hybrid III 50th % manikin; No helmet; Standard harness configuration (baseline 5 point configuration with a double shoulder strap, lap belt, and a negative-g or crotch strap); Input summary: Sled X accel = 20.13 G, Sled vel = 52.00 ft/s; **Successful Test**.

7.2 +Z-Axis Impact Testing

A total of 17 impact tests were conducted to evaluate the biodynamics of the THOR-K manikin in the Z-axis by varying peak G impact level, impact time-to-peak, and inclusion of a standard flight helmet. The data from the THOR-K and the Hybrid III 50th percentile manikin were compared with reference to the test parameters and specific measured variables. The test data tables have been separated into test conditions with and with-out a helmet to provide for accurate comparison of the manikin response data.

The impact level for the 10 G tests was 9.96 ± 0.12 G. The impact level for the 12 G test was 12.22 G. The impact level for the 20 G tests was 21.64 ± 0.28 G. The impact on-set rate for the 10 G, 30 ms tests was 33.03 ± 0.57 ms. The impact on-set rate for the 10 G, 70 ms tests was 66.25 ± 5.66 ms. The impact on-set rate for the 10 G, 100 ms tests was 95.65 ± 7.97 ms. These peak impact level and impact on-set rate summaries indicate that the HIA impact environment was well controlled during the duration of the program.

The average 20 G impact level was a little high, but was accepted in order to provide comparison of manikin data from previous programs with similar average 20 G impact levels. Select measured variables as a function of the input parameters are shown below. Tables 2 and 3 are response data without the manikin wearing the HGU-55/P flight helmet and with Table 2 using the input acceleration at a time-to-peak of 70 ms. Tables 4 and 5 are data for comparable tests with the manikin wearing the HGU-55/P flight helmet and with Table 4 using the input acceleration at a time-to-peak of 100 ms. Table 5 includes comparison data from the Hybrid III Aerospace manikin tests.

Table 2. THOR-K Response as Function of Peak Impact Level at 70 ms Rise Time (without/55P)

Peak Impact Level (G)	**Seat Pan Z-Axis Sum (lb)**	**Pelvis Z-Axis Acceleration (G)**	**Chest Z-Axis Acceleration (G)**	**Head Z-Axis Acceleration (G)**	**Neck Z-Axis Force (lb)**
10	2842 ± 54	22.53 ± 1.4	22.2 ± 0.2	24.3 ± 1.46	292 ± 19
20	5036 ± 52	61.8 ± 9.0	54.6 ± 1.2	56.8 ± 2.0	691 ± 31

Table 3. THOR-K Response as Function of Time-to-Peak at 10 G (without/55P)

Impact Time to Peak (ms)	**Seat Pan Z-Axis Sum (lb)**	**Pelvis Z-Axis Acceleration (G)**	**Chest Z-Axis Acceleration (G)**	**Head Z-Axis Acceleration (G)**	**Neck Z-Axis Force (lb)**
30	2654 ± 99	26.9 ± 0.6	25.9 ± 0.8	27.4 ± 1.9	323.6 ± 16.7
70	2842 ± 54	22.5 ± 1.4	22.2 ± 0.2	24.3 ± 1.5	291.8 ± 19.4
100	2558 ± 29	20.9 ± 0.2	20.4 ± 1.1	22.0 ± 0.1	262.7 ± 2.1

Table 4. THOR-K Response as Function of Peak Impact Level at 100 ms Rise Time (with/55P)

Peak Impact Level (G)	Seat Pan Z-Axis Sum (lb)	Pelvis Z-Axis Acceleration (G)	Chest Z-Axis Acceleration (G)	Head Z-Axis Acceleration (G)	Neck Z-Axis Force (lb)
8	1971	13.7	14.5	14.2	202.9
10	2544	23.0	23.2	22.1	308.9
12	3315	30.9	31.5	27.7	430.7

Table 5. THOR-K/Hybrid III Response as Function of Time-to-Peak at 10 G (w/55P)

Impact Time-to-Peak (ms)	Seat Pan Z-Axis Sum (lb)	Pelvis Z-Axis Acceleration (G)	Chest Z-Axis Acceleration (G)	Head Z-Axis Acceleration (G)	Neck Z-Axis Force (lb)
30 Aero	2796 2708	29.3 22.4	28.7 22.5	27.7 21.4	386.3 266.1
70 Aero	2754 2608	19.3 18.2	20.1 17.2	20.2 15.3	295.5 197.7
100 Aero	2544 2023	23.0 14.3	23.2 12.8	22.14 11.4	308.9 142.6

The THOR-K response data as a function of impact level shows the values increasing as the G-level increases regardless of wearing a helmet. The THOR-K response data as a function of input rise-time or time-to-peak G-level was in-conclusive, although the majority of the parameters indicated the manikin had maximum response at the 30 ms time-to-peak test condition. The data without the helmet showed a trend for the majority of the data sets to decrease in value as the rise-time increased indicating a sensitivity to the input pulse frequency. The data with a helmet indicated less of a trend as the 70 ms data had the smallest values, but only single tests were completed per condition. This test configuration was also the only configuration with comparable Hybrid III 50th percentile Aerospace manikin data. The Hybrid III data had smaller peak values in all test configurations, especially at 100 ms time-to-peak. Some of the Hybrid III values were 50% less than the THOR-K response values.

An analysis of the linearity of the THOR-K dynamic response was also conducted using the peak response data from the test parameters shown in Tables 2 through 5. Table 6 provides a summary of the correlation coefficient values for the selected parameters. Figures 11 through 14 graphically present the linearity of the THOR-K response for selected measured parameters as a function of peak impact acceleration. This was completed for input levels at both 70 ms and 100 ms time-to-peak.

Table 6. THOR-K Linear Correlation Coefficient Values for Select Parameters as Function of Z-Axis Input Acceleration

Impact Time to Peak (ms)	Seat Pan Z-Axis Sum (lb)	Pelvis Z-Axis Acceleration (G)	Chest Z-Axis Acceleration (G)	Head Z-Axis Acceleration (G)	Neck Z-Axis Force (lb)
70	0.991	0.982	0.998	0.999	0.999
100	0.998	0.974	0.978	0.988	0.979

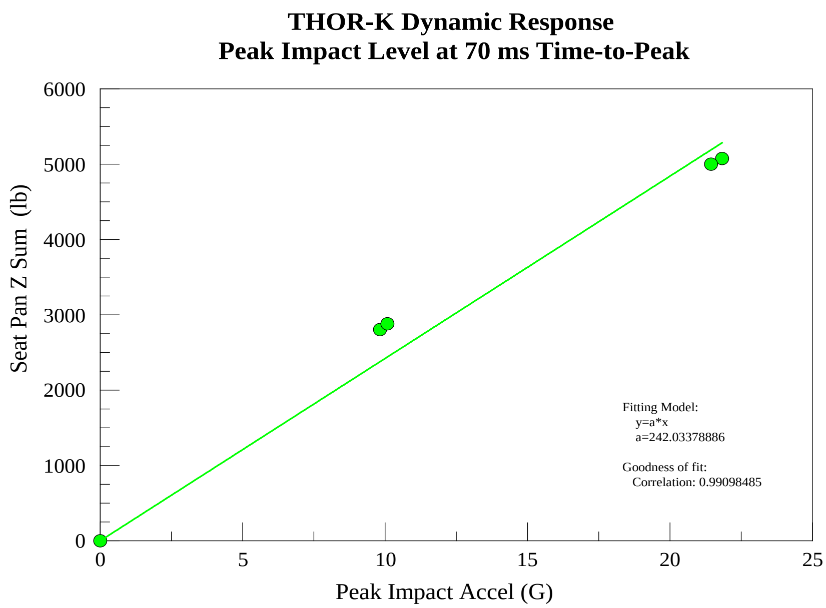


Figure 12. THOR-K Seat Pan Load as a Function of Peak Z-Axis Input Accel. (70 ms time-to-peak)

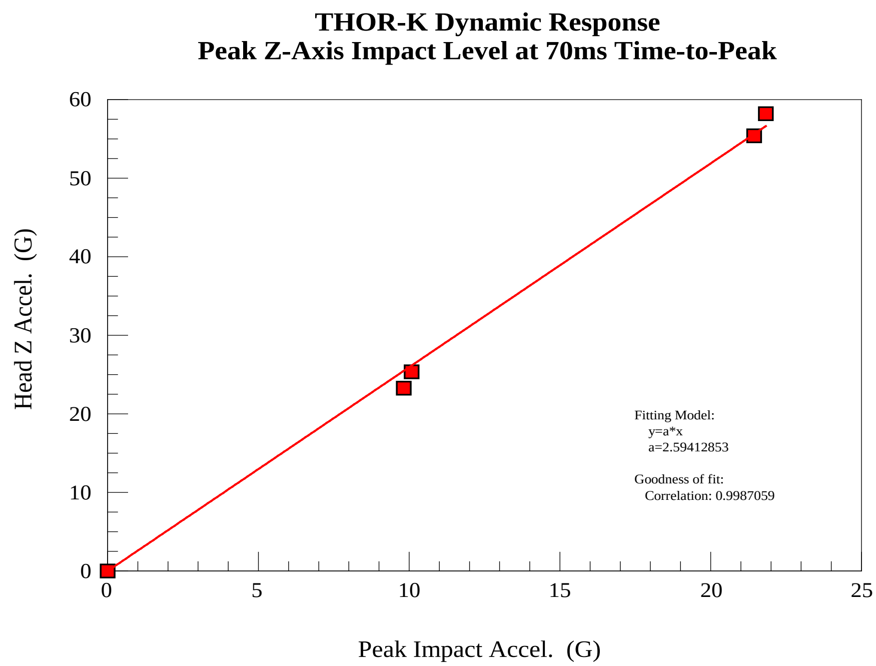


Figure 13. THOR-K Head Z Accel. as a Function of Peak Z-Axis Input Accel. (70 ms time-to-peak)

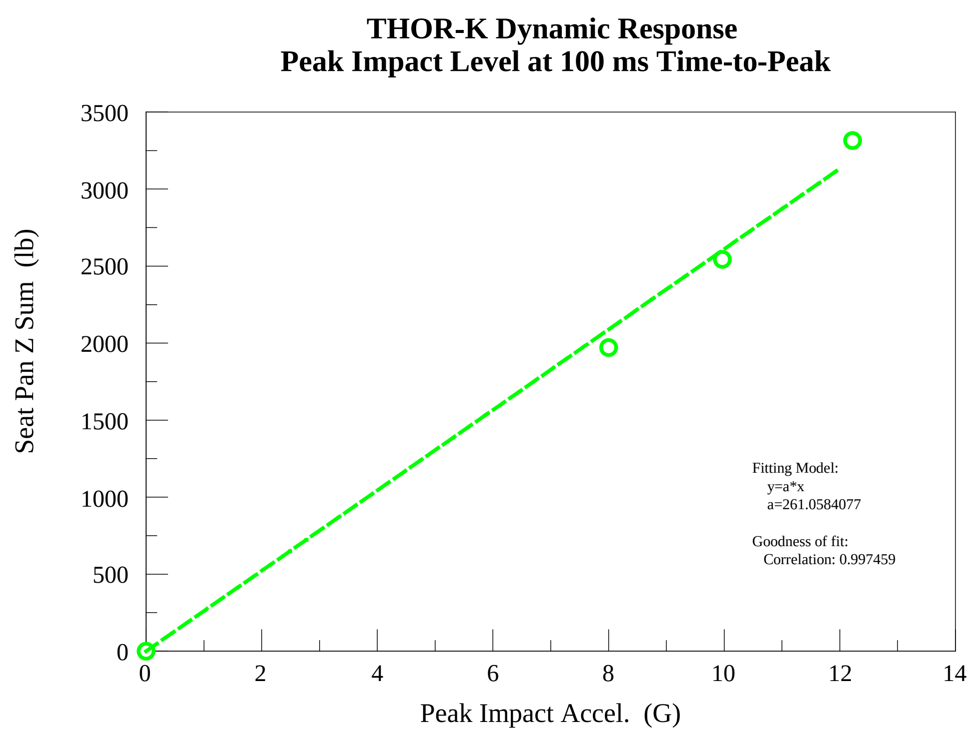


Figure 14. THOR-K Seat Pan Load as a Function of Peak Z-Axis Input Accel. (100 ms time-to-peak)

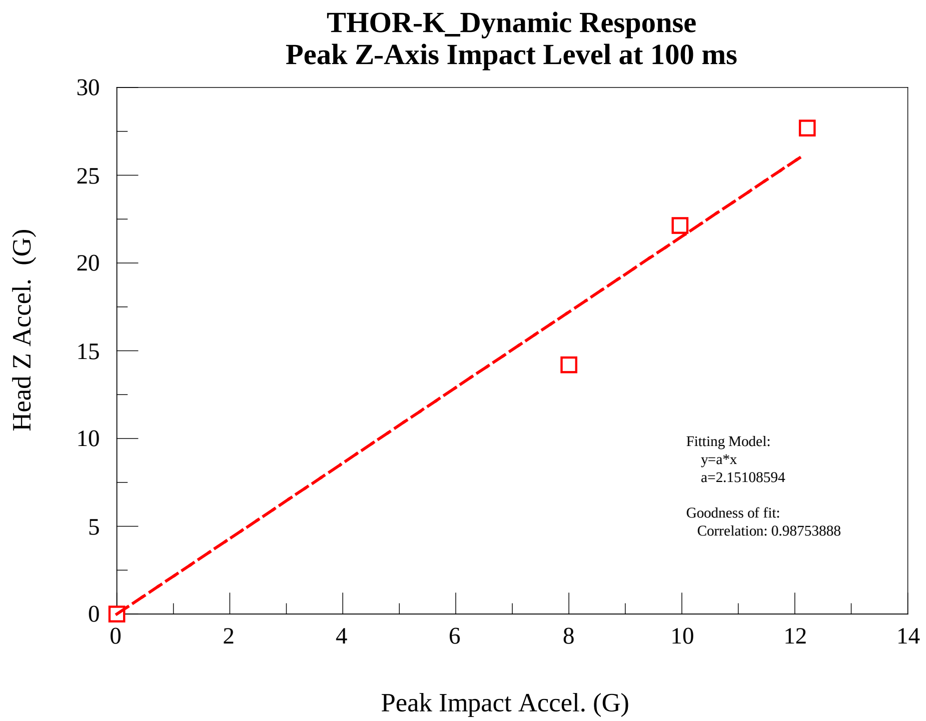


Figure 15. THOR-K Head Z Accel. as a Function of Peak Z-Axis Input Accel. (100 ms time-to-peak)

All four figures show that the THOR-K has very good linearity of response out to a 20 G impact for the selected measured parameters during the +z-axis impacts. Seat pan load was chosen as it is a good representative of whole body response to a vertical impact. The data from Table 6 show excellent correlation values that range from r = 0.974 to r = 0.999. The head z-axis acceleration and neck z-axis compressive load as a function of impact level with a 70 ms time-to-peak had the best correlation values with r = 0.999. The 70 ms time-to-peak data had an average correlation coefficient value of r = 0.994 ± 0.007, and the 100 ms time-to-peak had an average correlation coefficient value of r = 0.983 ± 0.010 indicating that the different input frequency had very little effect on the linearity of the THOR-K dynamic response. The overall average correlation value for this parameter data set is r = 0.989 ± 0.010 which indicates very good linearity for the THOR-K data parameters evaluated as a function of increasing z-axis input acceleration.

7.3 -X-Axis Impact Testing

A total of 12 impact tests were conducted to evaluate the biodynamics of the THOR-K manikin in the X-axis by varying peak G impact level, impact on-set rate, and inclusion of a standard flight helmet. The data from the THOR-K and the Hybrid III 50% tile manikin were compared with reference to the test parameters and specific measured variables. The test data tables have been separated into test conditions with and with-out a helmet to provide for accurate comparison of the manikin response data.

The impact level for the 8 G tests was 7.99 ± 0.04 G. The impact level for the 10 G tests was 9.95 ± 0.08 G. The impact level for the 20 G tests was 20.3 ± 0.13 G. The impact on-set rate for the 8 G, 100 ms tests was 81.2 ± 0.54 ms. The impact on-set rate for the 10 G, 70 ms tests was 60.83 ± 0.50 ms. The impact on-set rate for the 10 G, 100 ms test was 88.5 ms. The impact on-set rate for the 20 G, 70 ms tests was 51.3 ± 0.13 ms. These peak impact level and impact on-set rate summaries indicate that the HIA impact environment was well controlled during the duration of the program.

The average 20 G impact level was more in-line with the expected value. Select measured variables as a function of the input parameters are shown below. Information in Table 7 are response data without the manikin wearing the HGU-55/P flight helmet at a time-to-peak of 70 ms. Information in Table 8 are data for comparable tests with the manikin wearing the HGU-55/P flight helmet at a time-to-peak of 100 ms.

Table 7. THOR-K Response as Function of Peak Impact Level at 70 ms Rise Time (without/55P)

Peak Impact Level (G)	Resultant Harness Load (lb)	Pelvis X-Axis Acceleration (G)	Chest X-Axis Acceleration (G)	Head X-Axis Acceleration (G)	Neck My Torque (in-lb)
10	3041 ± 75	17.6 ± 1.03	18.2 ± 2.0	16.1 ± 1.05	151.9 ± 5.3
20	7339 ± 126	45.13 ± 1.8	47.6 ± 2.8	34.8 ± 4.34	230.8 ± 11.3

Table 8. THOR-K Response as Function of Peak Impact Level at 100 ms Rise Time (with/55P)

Peak Impact Level (G)	Resultant Harness Load (lb)	Pelvis X-Axis Acceleration (G)	Chest X-Axis Acceleration (G)	Head X-Axis Acceleration (G)	Neck My Torque (in-lb)
8 Aero	2228 1906 ± 25.7	12.5 14.7 ± 0.3	12.5 12.6 ± 0.1	9.66 -----	129.0 233.4 ± 3.4
10	2822	15.8	16.7	11.54	152.7

The THOR-K response data as a function of impact level shows the values increasing as the G-level increases regardless of wearing a helmet. It is interesting to note that the THOR response without the helmet at 10 G and 70 ms was greater than the THOR response with the helmet at 10 G and 100 ms. There was insufficient data collected to evaluate the THOR-K response data as a function of input rise-time or time-to-peak G-level. The test configuration at 8 G with a helmet was the only configuration with comparable Hybrid III 50th percentile Aerospace manikin data. The Hybrid III data had smaller peak values in the majority of the measured parameters as also shown in the z-axis input data set. The Hybrid III 50th head acceleration data was not usable due to a data collection configuration error. Additional Hybrid III data is compared to the THOR-K in the following linearity analysis.

An analysis of the linearity of the THOR-K dynamic response was also conducted using the peak response data from the test parameters shown in Tables 7 and 8. Table 9 shows a summary of the correlation coefficient values for the parameters shown. Figures 15 through 18 graphically present the linearity of the THOR-K response for selected measured parameters as a function of peak impact acceleration. Figures 15 and 16 include some Hybrid III data points for comparison. This was completed for input levels at both 70 ms and 100 ms time-to-peak (100 ms data is with flight helmet).

Table 9. THOR-K Linear Correlation Coefficient Values for Select Parameters as Function of X-Axis Input Acceleration

Impact Time to Peak (ms)	Resultant Harness Load (lb)	Pelvis X-Axis Acceleration (G)	Chest X-Axis Acceleration (G)	Head X-Axis Acceleration (G)	Neck My Torque (in-lb)
70	0.996	0.991	0.989	0.988	0.973
100	0.999	0.999	0.998	0.999	0.999

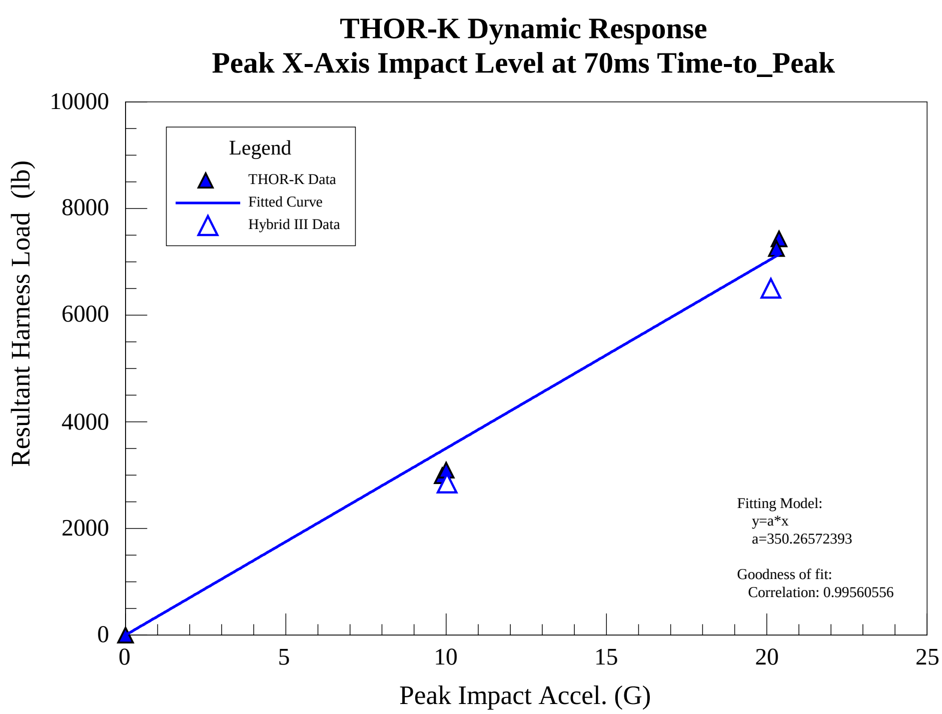


Figure 16. THOR-K Resultant Harness Load as a Function of Peak X-Axis Input Accel. (70 ms time-to-peak)

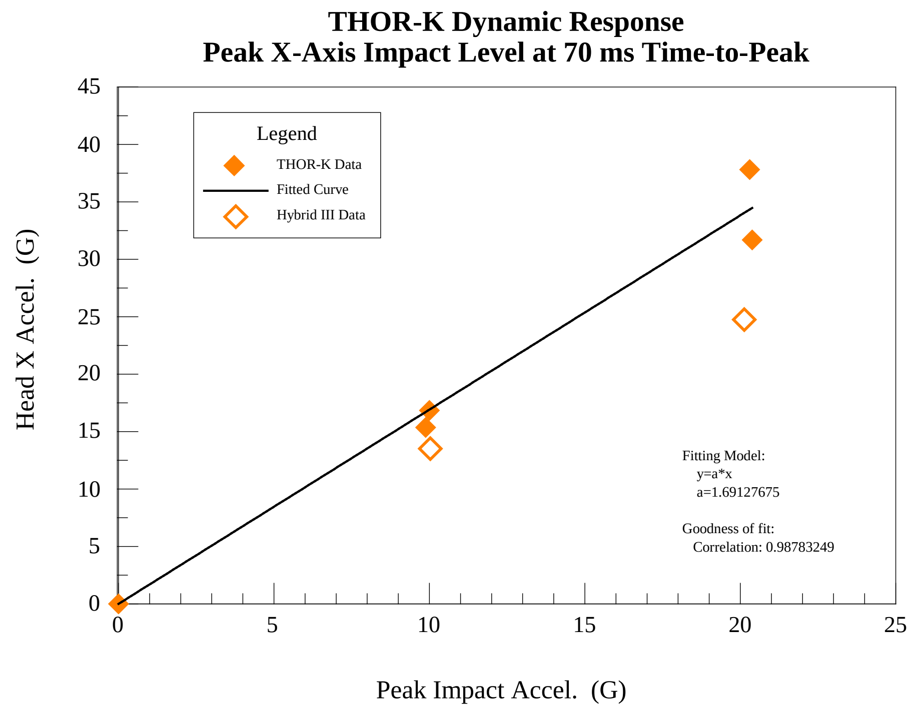


Figure 17. THOR-K Head X Accel. as a Function of Peak X-Axis Input Accel. (70 ms time-to-peak)

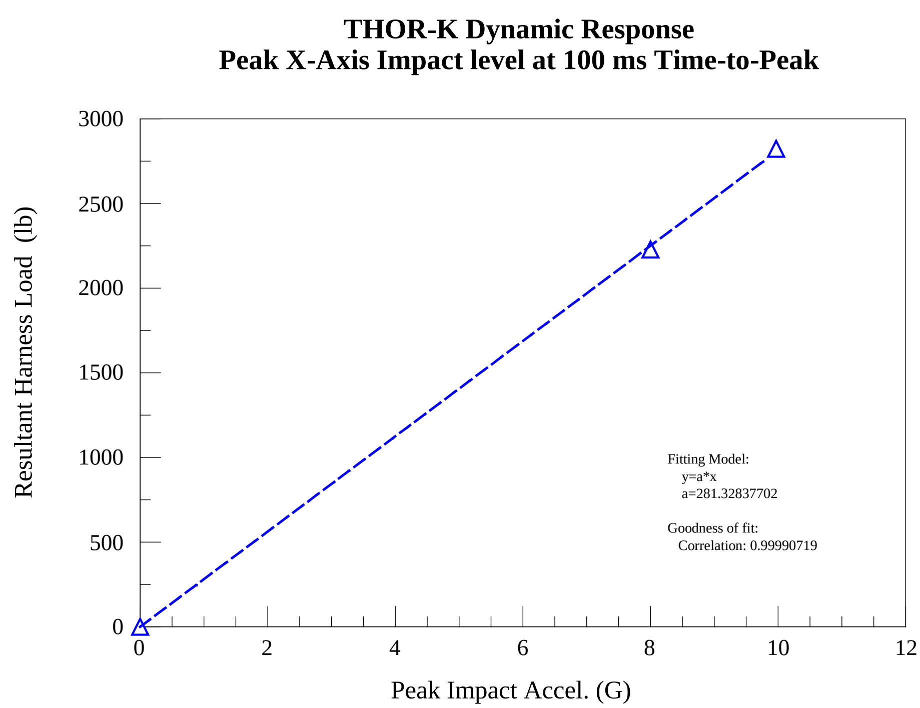


Figure 18. THOR-K Resultant Harness Load as a Function of Peak X-Axis Input Accel. (100 ms time-to-peak)

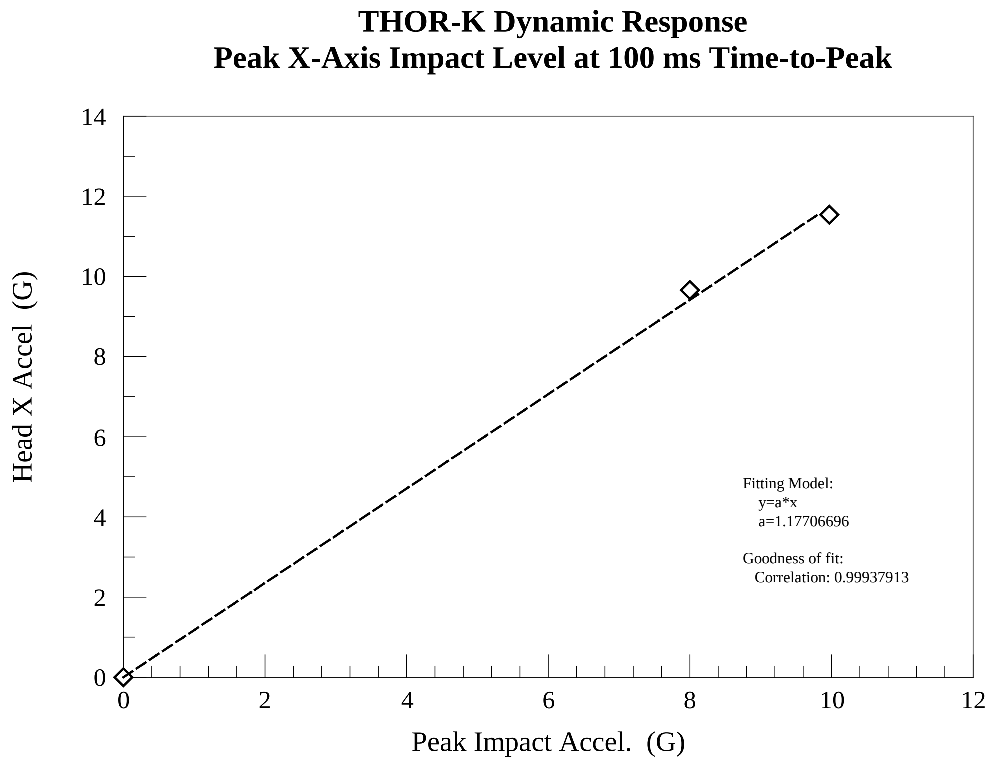


Figure 19. THOR-K Head X Accel. as a Function of Peak X-Axis Input Accel. (100 ms time-to-peak)

All four figures show that the THOR-K has very good linearity of response out to a 20 G impact for the selected measured parameters during a –x-axis impact. Figures 15 and 16 also indicated a trend for the Hybrid III to have a reduced peak response as the impact G level increased. Resultant harness load was chosen as it is a good representative of whole body response to impact. The data from Table 9 show excellent correlation coefficient values that range from r = 0.973 to r = 0.999. The resultant harness load, pelvis x-axis acceleration, and head x acceleration as a function of impact level with a time-to-peak of 100 ms all had the best correlation coefficient value of r = 0.999. The 70 ms time-to-peak data had an average correlation coefficient value of r = 0.987 ± 0.009, and the 100 ms time-to-peak had an average correlation coefficient value of r = 0.999 ± 0.001 indicating that the different input frequency had very little effect on the linearity of the THOR-K dynamic response for x-axis inputs. The overall average correlation value for this parameter data set is r = 0.993 ± 0.008 indicating very good linearity for the THOR-K data parameters evaluated as a function of increasing x-axis input acceleration.

7.4 +Y-Axis Impact Testing

A total of 11 impact tests were conducted to evaluate the biodynamics of the THOR-K manikin in the Y-axis by varying peak G impact level, and impact on-set rate. No lateral impact tests were conducted with a standard flight helmet. The data from the THOR-K and the Hybrid III

50% tile manikin were compared with reference to the test parameters and specific measured variables.

The impact level for the 10 G tests was 10.11 ± 0.11 G. The impact level for the 20 G tests was 20.12 ± 0.27 G. The impact on-set rate for the 10 G, 30 ms tests was 27.33 ± 0.51 ms. The impact on-set rate for the 10 G, 70 ms test was 74.8 ± 0.49 ms. The impact on-set rate for the 10 G, 100 ms was 96.6 ± 0.66 ms. These peak impact level and impact on-set rate summaries indicate that the HIA impact environment was well controlled during the duration of the program.

Select measured variables as a function of the input parameters are shown below. Information in Table 10 are response data without the manikin wearing the HGU-55/P flight helmet at a time-to-peak of 70 ms. Information in Table 11 are data for comparable tests with the manikin wearing the HGU-55/P flight helmet at a time-to-peak of 100 ms. Table 11 includes comparison data from the Hybrid III Aerospace manikin tests.

Table 10. THOR-K Response as Function of Peak Impact Level at 70 ms Rise Time (without/55P)

Peak Impact Level (G)	Resultant Harness Load (lb)	Chest Y-Axis Acceleration (G)	Head Y-Axis Acceleration (G)	Neck Mx Torque (in-lb)
10	407.0 ± 18.9	18.7 ± 1.3	15.2 ± 1.4	96.9 ± 3.40
20	999.1 ± 145.5	33.0 ± 0.2	35.9 ± 5.0	139.2 ± 39.8

Table 11. THOR-K Response as Function of Time-to-Peak at 10 G Impact (without/55P)

Time-to-Peak (ms)	Resultant Harness Load (lb)	Chest Y-Axis Acceleration (G)	Head Y-Axis Acceleration (G)	Neck Mx Torque (in-lb)
30 Aero	531.5 ± 11.3 526.7	22.5 ± 0.2 25.84	34.5 ± 6.3 18.59	116.4 ± 38.8 125.4
70 Aero	407.0 ± 18.9 568.3	18.7 ± 1.3 17.88	15.2 ± 1.4 11.77	96.9 ± 3.40 144.4
100 Aero	378.8 ± 44.9 451.9	12.7 ± 0.6 13.24	13.5 ± 4.1 11.11	97.7 ± 5.6 93.4

The THOR-K response data as a function of impact level shows the values increasing as the G-level increases. The data collected to evaluate the THOR-K response data as a function of input rise-time or time-to-peak G-level indicated that the manikin had a maximum response at the 30 ms time-to-peak test condition as compared to the Hybrid III Aero response data which showed the greatest peaks occurring at the 70 ms time-to-peak test condition. The test configurations at 10 G with the variable time-to-peak data were the only configurations with comparable Hybrid III 50th percentile Aerospace manikin data. The Hybrid III Aero data had similar peak values in

the majority of the measured parameters except for the head acceleration and neck response. The linear acceleration response measurements were similar with the 30 ms time-to-peak data having the greatest difference. The neck torque data was also similar; however, for this parameter, the 70 ms time-to-peak data had the greatest difference.

An analysis of the linearity of the THOR-K dynamic response was also conducted using the peak response data from the test parameters shown in Tables 10 and 11. Table 12 shows a summary of the correlation coefficient values for the parameters shown. Figures 19 to 21 present the linearity of the THOR-K response for selected measured parameters as a function of peak impact acceleration. This was completed for input levels at both 70 ms and 100 ms time-to-peak (100 ms data is with flight helmet).

Table 12. THOR-K Linear Correlation Coefficient Values for Select Parameters as Function of Y-Axis Input Acceleration

Impact Time to Peak (ms)	Resultant Harness Load (lb)	Chest Y-Axis Acceleration (G)	Head Y-Axis Acceleration (G)	Neck Mx Torque (in-lb)
70	0.976	0.995	0.984	0.918

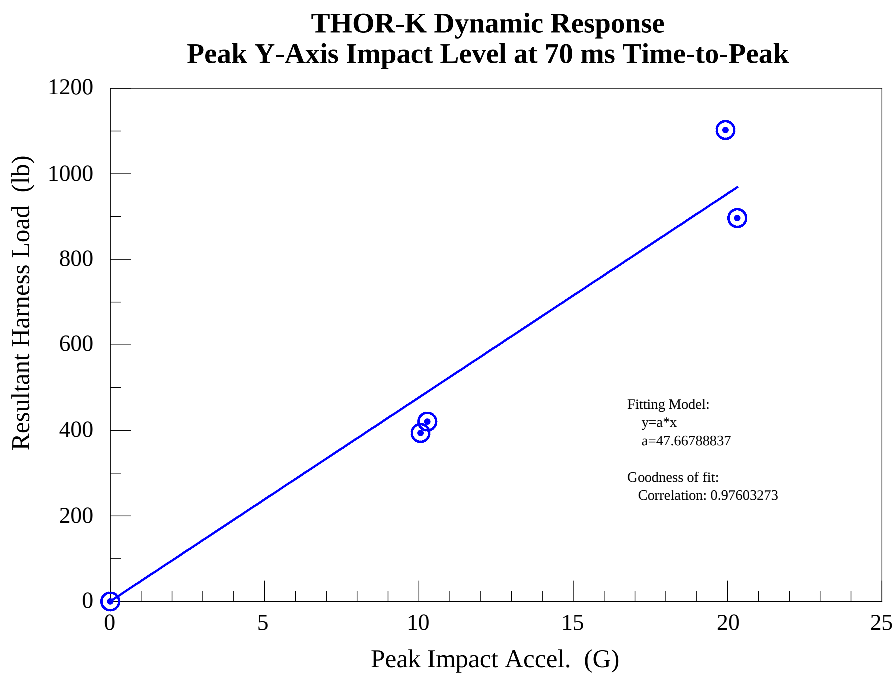


Figure 20. THOR-K Resultant Harness Load as a Function of Peak Y-Axis Input Accel. (70 ms time-to-peak)

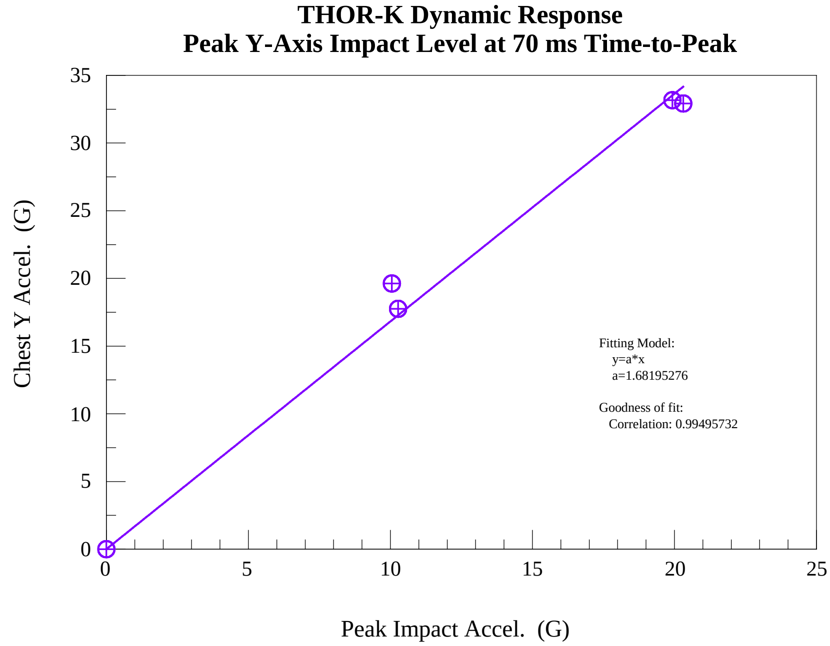


Figure 21. THOR-K Chest Y Accel as a Function of Peak Y-Axis Input Accel. (70 ms time-to-peak)

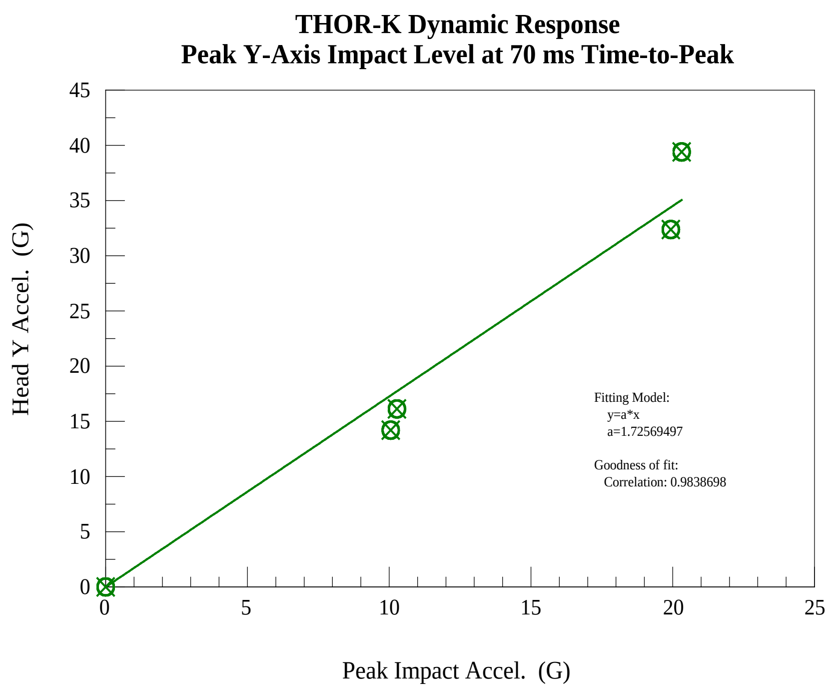


Figure 22. THOR-K Head Y Accel as a Function of Peak Y-Axis Input Accel. (70 ms time-to-peak)

All three figures show that the THOR-K has good linearity of response out to a 20 G impact for the selected measured parameters during a lateral y-axis impact. Data was only available as a function of input acceleration level for the data with a 70 ms time-to-peak. There were no data for the 100 ms time-to-peak condition at multiple input acceleration levels as was available for the z-axis and x-axis impact data sets. Resultant harness load was chosen as it is a good representative of whole body response to impact. The data from Table 12 show good correlation coefficient values that range from r = 0.918 to r = 0.995. The chest y-axis acceleration as a function of impact acceleration level with a 70 ms time-to-peak had the best correlation coefficient value of r = 0.995. The neck Mx torque correlation coefficient value (r = 0.918) was the lowest value for all the correlation values regardless of impact orientation. The overall average correlation value for this parameter data set is r = 0.968 ± 0.034 which indicates very good linearity for the THOR-K data parameters evaluated as a function of increasing x-axis input acceleration. However, the lateral y-axis impact data presented linearity results that were not as good as either the z-axis or x-axis linearity results.

8.0 SUMMARY AND CONCLUSIONS

A total of 39 impact tests were conducted to support a test program to evaluate the THOR-K manikin's biodynamic response for potential use in the development of advanced occupant seating systems by NASA and the USAF. The principle objective of this evaluation was to determine the biodynamic response of the THOR-K with particular emphasis on measuring the spinal and restraint harness loading for various impact orientations and loading conditions. This data would also be compared to the Hybrid III 50th percentile manikin response data in select test configurations. Testing was completed in three impact orientations: +z-axis, +y-axis, and –x-axis, and with input accelerations at various impact G-levels that ranged from 8 to 20 G peak value. Testing was also completed to determine the frequency response of the THOR-K manikin by varying the time-to-peak G of the applied input acceleration from 30 ms to 100 ms. The frequency response analysis will characterize how the subsystem mechanical properties affect energy amplification or attenuation of the entire ATD system during impact.

The +z-axis impact testing indicated that the THOR-K manikin displayed a very good linear response out to 20 G for the five measured parameters that were evaluated. An average linear correlation coefficient value was calculated to be r = 0.989 ± 0.010 with the head z-axis acceleration and neck z-axis compressive load as a function of impact level with a 70 ms time-to-peak having the best linear correlation coefficient values with r = 0.999. It should be pointed out that the majority of the linear regressions were completed with only 4-6 data points depending upon the measured parameter. The frequency response analysis indicated a trend for the manikin to have a maximum response at the 30 ms time-to-peak condition compared to the other time-to-peak conditions of 70 and 100 ms indicating a minimum natural frequency of around 6 Hz for the parameters evaluated. The Hybrid III data had smaller peak values in all test configurations, especially at the 100 ms rise-time where some of the Hybrid III values were 50% less than the corresponding THOR-K values.

The –x-axis impact testing indicated that the THOR-K manikin also displayed a very good linear response out to 20 G for the five measured parameters that were evaluated. An average linear correlation coefficient value was calculated to be r = 0.993 ± 0.008 with the resultant harness load, pelvis x-axis acceleration, and head x acceleration as a function of impact level with a time-to-peak of 100 ms having the best correlation coefficient value of r = 0.999. A limitation of the linearity assessment is that the measured parameters were limited to 6 or less data points per regression. There was insufficient time-to-peak data to assess the frequency response of the THOR-K, or to make an accurate comparison to the Hybrid III manikin in this impact configuration. However, the THOR-K and the Hybrid III were both run at a 10 G and 20 G impact level, and the Hybrid III data tended to be equivalent to or less than the THOR-K response based on the assessed parameters. The head and neck response data did highlight the fact that the Hybrid III neck is less stiff that than the THOR-K neck in forward flexion as evidenced by the Hybrid III neck My torque data being almost double the value for the THOR-K at both 10 and 20 G peak input accelerations (260 lb. vs 152 lb., and 643 lb. vs 231 lb. respectively).

The +y-axis impact testing indicated that the THOR-K manikin also displayed a linear response out to 20 G for the highlighted parameters that were evaluated, but the linearity was not as strong as was shown for the –x-axis and the +z-axis impact testing. An average linear correlation coefficient value was found to be r = 0.968 ± 0.034 with the chest y-axis acceleration as a function of impact level with a time to peak of 70 ms having the best correlation coefficient value of r = 0.995. The neck Mx torque as a function of impact level with a time to peak of 70 ms had the lowest linear correlation coefficient of all the selected parameters for all impact orientations with a value of r = 0.918. The frequency response analysis indicated a trend for the manikin to have a maximum response at the 30 ms time-to-peak condition compared to the other time-to-peak conditions of 70 and 100 ms indicating a minimum natural frequency of around 6 Hz. This was similar to the results for the frequency response analysis for the +z-axis input condition. The Hybrid III manikin's peak response was very similar to the THOR-K response for all parameters evaluated except head y-axis acceleration where the Hybrid III acceleration was approximately half the value of the THOR-K. The whole body dynamic response of the Hybrid III was greater than the THOR-K at the 70 ms and 100 ms time-to-peak test conditions as indicated by the greater resultant loading into the restraint harness.

In general, the THOR-K provided good linear response across the various test conditions out to a 20 G input acceleration for the measured test parameters evaluated. The THOR-K response was maximized at the 30 ms time-to-peak input condition. The THOR-K responded in a similar fashion to the Hybrid III manikin in terms of peak values with the exception of the head and neck responses which were consistently lower regardless of peak input acceleration or the input acceleration's time-to-peak value. The exception to this was the forward neck flexion (My torque values) response for the Hybrid III being approximately double the response for the THOR-K neck. It is recommended that additional testing be completed over a broader range of input acceleration time-to-peak values for all input configurations in the orthogonal axes, and over a broader range of peak input accelerations for the x-axis orientation.

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GLOSSARY

AIS	Abbreviated Injury Scale
AFRL	Air Force Research Laboratory
DAS	Data Acquisition System
DTS	Diversified Technical Systems
DoD	Department of Defense
FE	Finite Element
HIA	Horizontal Impulse Accelerator
HPW	Human Performance Wing
THOR	Test device for Human Occupant Restraint
USN	United States Navy
USAF	United States Air Force
WPAFB	Wright Patterson Air Force Base

ATTACHMENT 1: ELECTRONIC DATA CHANNELS (THOR-K TESTS)

PROGRAM:	TEST DATES:
STUDY NUMBER: 201302 (THOR Manikin)	TEST NUMBERS:
FACILITY: HORIZONTAL IMPULSE ACCELERATOR	SAMPLE RATE: 10K
DATA COLLECTION SYSTEM: TDAS PRO	FILTER FREQUENCY:
	TRANSDUCER RANGE (VOLTS): +/- 5V

DATA CHANNEL	DATA POINT	TRANSDUCER MFG. & MODEL	SERIAL NUMBER	PRE-CAL		POST-CAL		% D	DAS SENSITIVITY	BRIDGE	FULL SCALE
				DATE	SENS	DATE	SENS				
1	INT HEAD X ACCEL (G)	ENDEVCO 7264C-2K	P74956	18-Oct-10	.1851 mv/g at 10V exc	NA	NA	NA	.01851 mv/v/g	FULL	100 G
2	INT HEAD Y ACCEL (G)	ENDEVCO 7264C-2K	P74776	18-Oct-10	.1752 mv/g at 10V exc	NA	NA	NA	.01752 mv/v/g	FULL	100 G
3	INT HEAD Z ACCEL (G)	ENDEVCO 7264C-2K	P74968	18-Oct-10	.1790 mv/g at 10V exc	NA	NA	NA	.01790 mv/v/g	FULL	100 G
4	INT HEAD Rx ANG RATE (RAD/SEC)	DTS ARS PRO-18K	ARS4713	12-Jul-12	.09659 mv/deg/sec at 5V exc	NA	NA	NA	.09659 mv/deg/sec	FULL	18000 DEG/SEC
5	INT HEAD Ry ANG RATE (RAD/SEC)	DTS ARS PRO-18K	ARS4734	12-Jul-12	.09484 mv/deg/sec at 5V exc	NA	NA	NA	.09484 mv/deg/sec	FULL	18000 DEG/SEC
6	INT HEAD Rz ANG RATE (RAD/SEC)	DTS ARS PRO-18K	ARS4725	12-Jul-12	.09557 mv/deg/sec at 5V exc	NA	NA	NA	.09557 mv/deg/sec	FULL	18000 DEG/SEC
7	INT UPPER NECK X FORCE (LB)	DENTON 3454J	76	23-Jan-12	10.4 uv/lb at 10V exc	NA	NA	NA	.00104 mv/v/lb	FULL	2000 LB
8	INT UPPER NECK Y FORCE (LB)	DENTON 3454J	76	23-Jan-12	10.5 uv/lb at 10V exc	NA	NA	NA	.00105 mv/v/lb	FULL	2000 LB
9	INT UPPER NECK Z FORCE (LB)	DENTON 3454J	76	23-Jan-12	3.95 uv/lb at 10V exc	NA	NA	NA	.000395 mv/v/lb	FULL	3000 LB

10	INT UPPER NECK Mx TORQUE (IN-LB)	DENTON 3454J	76	23-Jan-12	6.77 uv/in-lb at 10V exc	NA	NA	NA	.000677 mv/v/in-lb	FULL	2500 IN-LB
11	INT UPPER NECK My TORQUE (IN-LB)	DENTON 3454J	76	23-Jan-12	6.85 uv/in-lb at 10V exc	NA	NA	NA	.000685 mv/v/in-lb	FULL	2500 IN-LB
12	INT UPPER NECK Mz TORQUE (IN-LB)	DENTON 3454J	76	23-Jan-12	11.25 uv/in-lb at 10V exc	NA	NA	NA	.001125 mv/v/in-lb	FULL	2500 IN-LB
13	INT LOWER NECK X FORCE (LB)	DENTON 4366J	85	14-Jan-12	7.54 uv/lb at 10V exc	NA	NA	NA	.000754 mv/v/lb	FULL	3000 LB
14	INT LOWER NECK Y FORCE (LB)	DENTON 4366J	85	14-Jan-12	7.54 uv/lb at 10V exc	NA	NA	NA	.000754 mv/v/lb	FULL	3000 LB
15	INT LOWER NECK Z FORCE (LB)	DENTON 4366J	85	14-Jan-12	3.12 uv/lb at 10V exc	NA	NA	NA	.000312 mv/v/lb	FULL	3000 LB
16	INT LOWER NECK Mx TORQUE (IN-LB)	DENTON 4366J	85	14-Jan-12	4.53 uv/in-lb at 10V exc	NA	NA	NA	.000453 mv/v/in-lb	FULL	4000 IN-LB
17	INT LOWER NECK My TORQUE (IN-LB)	DENTON 4366J	85	14-Jan-12	4.57 uv/in-lb at 10V exc	NA	NA	NA	.000457 mv/v/in-lb	FULL	4000 IN-LB
18	INT LOWER NECK Mz TORQUE (IN-LB)	DENTON 4366J	85	14-Jan-12	7.63 uv/in-lb at 10V exc	NA	NA	NA	.000763 mv/v/in-lb	FULL	2000 IN-LB
19	INT NECK SPRING FRONT (LB)	DENTON 6005J	77	14-Jan-12	37.78 uv/lb at 10V exc	NA	NA	NA	.003778 mv/v/lb	FULL	1000 LB
20	INT NECK SPRING REAR (LB)	DENTON 6005J	78	20-Jan-12	38.36 uv/lb at 10V exc	NA	NA	NA	.003836 mv/v/lb	FULL	1000 LB
21	INT OC Ry ANGLE (DEG)	SFERENICE 50ESC	007	20-Jun-12	30.35 mv/deg at 10V exc	NA	NA	NA	3.035 mv/v/deg	FULL	180 DEG

22	INT UPPER LEFT THORAX Dx (V)	HUMANETICS IF-364-C-R2-W253	DJ2612	02-Jan-12	1000 mv/v at 5 V exc	NA	NA	NA	1000 mv/v/v	FULL	5 V
23	INT UPPER LEFT THORAX Ry (DEG)	HUMANETICS 9945	DJ4106	03-Jan-12	30.78 mv/deg at 10V exc	NA	NA	NA	3.0780 mv/v/deg	FULL	75 DEG
24	INT UPPER LEFT THORAX Rz (DEG)	HUMANETICS 9945	DJ4108	03-Jan-12	30.439 mv/deg at 10V exc	NA	NA	NA	3.0439 mv/v/deg	FULL	75 DEG
25	INT UPPER RIGHT THORAX Dx (V)	HUMANETICS IF-364-C-R2-W253	DJ2613	02-Jan-12	1000 mv/v at 5V exc	NA	NA	NA	1000 mv/v/v	FULL	5 V
26	INT UPPER RIGHT THORAX Ry (DEG)	HUMANETICS 9945	DI7753	10-May-12	30.204 mv/deg at 10V exc	NA	NA	NA	3.0204 mv/v/deg	FULL	75 DEG
27	INT UPPER RIGHT THORAX Rz (DEG)	HUMANETICS 9945	DI7752	10-May-12	30.537 mv/deg at 10V exc	NA	NA	NA	3.0537 mv/v/deg	FULL	75 DEG
28	INT LOWER LEFT THORAX Dx (V)	HUMANETICS IF-364-C-R2-W253	DJ4421	08-Apr-11	1000 mv/v at 5 V exc	NA	NA	NA	1000 mv/v/v	FULL	5 V
29	INT LOWER LEFT THORAX Ry (DEG)	HUMANETICS 9945	DI7903	05-Jan-12	30.345 mv/deg at 10V exc	NA	NA	NA	3.0345 mv/v/deg	FULL	75 DEG
30	INT LOWER LEFT THORAX Rz (DEG)	HUMANETICS 9945	DJ0023	05-Jan-12	30.296 mv/deg at 10V exc	NA	NA	NA	3.0296 mv/v/deg	FULL	75 DEG
31	INT LOWER RIGHT THORAX DX (V)	HUMANETICS IF-364-C-R2-W253	DJ2614	08-Apr-11	1000 mv/v at 5V exc	NA	NA	NA	1000 mv/v/v	FULL	5 V
32	INT LOWER RIGHT THORAX Ry (DEG)	HUMANETICS 9945	DJ4107	03-Jan-12	30.186 mv/deg at 10V exc	NA	NA	NA	3.0186 mv/v/deg	FULL	75 DEG

33	INT LOWER RIGHT THORAX Rz (DEG)	HUMANETICS 9945	DJ4109	03-Jan-12	30.615 mv/deg at 10V exc	NA	NA	NA	3.0615 mv/v/deg	FULL	75 DEG
34	INT LEFT CLAVICLE MFX (LB)	HUMANETICS 9590J	DJ2180	12-Jan-12	21.70 uv/lb at 10V exc	NA	NA	NA	.002170 mv/v/lb	FULL	450 LB
35	INT LEFT CLAVICLE MFZ (LB)	HUMANETICS 9590J	DJ2180	12-Jan-12	21.87 uv/lb at 10V exc	NA	NA	NA	.002187 mv/v/lb	FULL	450 LB
36	INT LEFT CLAVICLE LFX (LB)	HUMANETICS 9590J	DJ2180	12-Jan-12	21.32 uv/lb at 10V exc	NA	NA	NA	.002132 mv/v/lb	FULL	450 LB
37	INT LEFT CLAVICLE LFZ (LB)	HUMANETICS 9590J	DJ2180	12-Jan-12	2150 uv/lb at 10V exc	NA	NA	NA	.002150 mv/v/lb	FULL	450 LB
38	INT STERNUM X ACCEL (G)	ENDEVCO 7264C-2K	P52006	18-Oct-11	.2070 mv/g at 10V exc	NA	NA	NA	.02070 mv/v/g	FULL	100 G
39	INT T1 X ACCEL (G)	ENTRAN EGEB6Q-2000	05G15-L04	05-Nov-12	.2164 mv/g at 10V exc	NA	NA	NA	.02164 mv/v/g	FULL	100 G
40	INT T1 Y ACCEL (G)	ENDEVCO 7264C-2K	P58773	18-Oct-10	.2015 mv/g at 10V exc	NA	NA	NA	.02015 mv/v/g	FULL	100 G
41	INT T1 Z ACCEL (G)	ENDEVCO 7264C-2K	P68063	05-Nov-12	.2405 mv/g at 10V exc	NA	NA	NA	.02405 mv/v/g	FULL	100 G
42	INT T12 X ACCEL (G)	ENDEVCO 7264C-2K	P52029	05-Nov-12	.1766 mv/g at 10V exc	NA	NA	NA	.01766 mv/v/g	FULL	100 G
43	INT T12 Y ACCEL (G)	ENDEVCO 7264C-2K	P64098	05-Nov-12	.2293 mv/g at 10V exc	NA	NA	NA	.02293 mv/v/g	FULL	100 G
44	INT T12 Z ACCEL (G)	ENDEVCO 7264C-2K	P68077	05-Nov-12	.2283 mv/g at 10V exc	NA	NA	NA	.02283 mv/v/g	FULL	100 G
45	INT CHEST X AT T6 ACCEL (G)	ENDEVCO 7264C-2K	P52012	05-Nov-12	.1752 mv/g at 10V exc	NA	NA	NA	.01752 mv/v/g	FULL	100 G
46	INT CHEST Y AT T6 ACCEL (G)	ENDEVCO 7264C-2K	P52053	05-Nov-12	.1816 mv/g at 10V exc	NA	NA	NA	.01816 mv/v/g	FULL	100 G

47	INT CHEST Z AT T6 ACCEL (G)	ENDEVCO 7264C-2K	P68607	05-Nov-12	.2032 mv/g at 10V exc	NA	NA	NA	.02032 mv/v/g	FULL	100 G
48	INT THORACIC SPINE X FORCE (LB)	HUMANETICS 1911A	125	18-Jan-12	6.39 uv/lb at 10V exc	NA	NA	NA	.000639 mv/v/lb	FULL	3000 LB
49	INT THORACIC SPINE Y FORCE (LB)	HUMANETICS 1911A	125	18-Jan-12	6.40 uv/lb at 10V exc	NA	NA	NA	.000640 mv/v/lb	FULL	3000 LB
50	INT THORACIC SPINE Z FORCE (LB)	HUMANETICS 1911A	125	18-Jan-12	2.74 uv/lb at 10V exc	NA	NA	NA	.000274 mv/v/lb	FULL	4000 LB
51	INT THORACIC SPINE Mx TORQUE (IN-LB)	HUMANETICS 1911A	125	18-Jan-12	2.44 uv/in-lb at 10V exc	NA	NA	NA	.000244 mv/v/in-lb	FULL	6000 IN-LB
52	INT THORACIC SPINE My TORQUE (IN-LB)	HUMANETICS 1911A	125	18-Jan-12	2.08 uv/in-lb at 10V exc	NA	NA	NA	.000208 mv/v/in-lb	FULL	8000 IN-LB
53	INT RIGHT ACETABULAR X FORCE (LB)	HUMANETICS 3455J	79	14-Jan-12	5.41 uv/lb at 10V exc	NA	NA	NA	.000541 mv/v/lb	FULL	5000 LB
54	INT RIGHT ACETABULAR Y FORCE (LB)	HUMANETICS 3455J	79	14-Jan-12	2.66 uv/lb at 10V exc	NA	NA	NA	.000266 mv/v/lb	FULL	3000 LB
55	INT RIGHT ACETABULAR Z FORCE (LB)	HUMANETICS 3455J	79	14-Jan-12	7.33 uv/lb at 10V exc	NA	NA	NA	.000733 mv/v/lb	FULL	3000 LB
56	INT PELVIS X ACCEL (G)	ENDEVCO 7264C-2K	P52004	05-Nov-12	.2101 mv/g at 10V exc	NA	NA	NA	.02101 mv/v/g	FULL	100 G
57	INT PELVIS Y ACCEL (G)	ENDEVCO 7264C-2K	P51993	05-Nov-12	.1995 mv/g at 10V exc	NA	NA	NA	.01995 mv/v/g	FULL	100 G
58	INT PELVIS Z ACCEL (G)	ENDEVCO 7264C-2K	P52005	05-Nov-12	.1984 mv/g at 10V exc	NA	NA	NA	.01984 mv/v/g	FULL	100 G

59	INT LEFT ANKLE Rx ANGLE (DEG)	CONTELEC PD210-4B	7921-0037	12-Dec-12	31.92 mv/deg at 10V exc	NA	NA	NA	3.192 mv/v/deg	FULL	180 DEG
60	INT LEFT ANKLE Ry ANGLE (DEG)	CONTELEC PD210-4B	7921-0225	14-Dec-12	30.97 mv/deg at 10V exc	NA	NA	NA	3.097 mv/v/deg	FULL	180 DEG
61	INT LEFT ANKLE Rz ANGLE (DEG)	CONTELEC PD210-4B	7921-0539	14-Dec-12	31.37 mv/deg at 10V exc	NA	NA	NA	3.137 mv/v/deg	FULL	180 DEG
62	INT RIGHT ANKLE Rx ANGLE (DEG)	CONTELEC PD210-4B	7921-0520	14-Dec-12	31.68 mv/deg at 10v exc	NA	NA	NA	3.168 mv/v/deg	FULL	180 DEG
63	INT RIGHT ANKLE Ry ANGLE (DEG)	CONTELEC PD210-4B	7921-0540	17-Dec-12	31.36 mv/deg at 10V exc	NA	NA	NA	3.136 mv/v/deg	FULL	180 DEG
64	INT RIGHT ANKLE Rz ANGLE (DEG)	CONTELEC PD210-4B	7921-0224	17-Dec-12	31.28 mv/deg at 10V exc	NA	NA	NA	3.128 mv/v/deg	FULL	180 DEG
65	SLED X ACCEL (G)	ENDEVCO 2262A-200	FR31	20-Nov-12	5.0876 mv/g at 10V exc	04-Mar-13	5.1786 mv/g at 10V exc	1.8	.50876 mv/v/g	FULL	50 G
66	SLED VELOCITY (FT/SEC)	GLOBE IND. 22A672-2	5	20-Nov-12	24.621 mv/ft/sec	19-Mar-13	24.662 mv/ft/sec	1.70	24.621 mv/ft/sec	FULL	100 FT/SEC
66	RIGHT KNEE FORCE (LB)	STRAINSERT FL2.5-2SGKT	Q-7588-1	19-Dec-12	7.99 uv/lb at 10V exc	27-Feb-13	7.99 uv/lb at 10V exc	0.00	.000799 mv/v/lb	FULL	2500 LB
67	LEFT HEADREST X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q-3294-1	01-Jun-12	8.07 uv/lb at 10V exc	19-Feb-13	8.04 uv/lb at 10V exc	-0.4	.000807 mv/v/lb	FULL	2500 LB
68	RIGHT HEADREST X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q-3294-2	9-Aug-12	8.00 uv/lb at 10V exc	25-Feb-13	8.04 uv/lb at 10V exc	0.5	.000800 mv/v/lb	FULL	2500 LB
69	CENTER HEADREST X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q-7588-3	10-Dec-12	8.04 uv/lb at 10V exc	27-Feb-13	8.01 uv/lb at 10v exc	-0.4	.000804 mv/v/lb	FULL	2500 LB
70	LEFT UPPER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SGKT	Q19614-4	16-Feb-12	7.95 uv/lb at 10V exc	21-Feb-13	7.93 uv/lb at 10V exc	-0.3	.000795 mv/v/lb	FULL	2500 LB
71	RIGHT UPPER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SGKT	Q19614-5	9-Feb-12	7.97 uv/lb at 10V exc	20-Feb-13	7.99 uv/lb at 10V exc	0.3	.000797 mv/v/lb	FULL	2500 LB

72	CENTER UPPER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SGKT	Q19614-6	09-Feb-12	7.98 uv/lb at 10V exc	20-Feb-13	7.97 uv/lb at 10V exc	-0.1	.000798 mv/v/lb	FULL	2500 LB
73	LEFT LOWER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q19614-1	16-Feb-12	7.97 uv/lb at 10V exc	25-Feb-13	7.95 uv/lb at 10V exc	-0.3	.000797 mv/v/lb	FULL	2500 LB
74	RIGHT LOWER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q19614-3	15-Aug-12	7.86 uv/lb at 10V exc	20-Mar-13	7.93 uv/lb at 10V exc	0.9	.000786 mv/v/lb	FULL	2500 LB
75	CENTER LOWER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q19614-2	09-Aug-12	7.94 uv/lb at 10V exc	25-Feb-13	7.93 uv/lb at 10V exc	-0.1	.000794 mv/v/lb	FULL	2500 LB
76	LEFT SEAT PAN Z FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-7135-4	7-Aug-12	7.91 uv/lb at 10V exc	08-Mar-13	7.89 uv/lb at 10V exc	-0.3	.000791 mv/v/lb	FULL	2500 LB
77	RIGHT SEAT PAN Z FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-7135-2	15-Jul-12	7.96 uv/lb at 10V exc	15-Mar-13	7.93 uv/lb at 10V exc	-0.4	.000796 mv/v/lb	FULL	2500 LB
78	CENTER SEAT PAN Z FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-7135-3	17-Aug-12	7.83 uv/lb at 10V exc	8-Mar-13	7.95 uv/lb at 10V exc	1.5	.000783 mv/v/lb	FULL	2500 LB
79	LEFT SHOULDER X FORCE (LB)	MICH SCI 4000	1 (Z)	08-Aug-11	12.86 uv/lb at 10V exc				.001286 mv/v/lb	FULL	1500 LB
80	LEFT SHOULDER Y FORCE (LB)	MICH SCI 4000	1 (Y)	08-Aug-11	13.80 uv/lb at 10V exc				.001380 mv/v/lb	FULL	1500 LB
81	LEFT SHOULDER Z FORCE (LB)	MICH SCI 4000	1 (X)	08-Aug-11	13.46 uv/lb at 10V exc				.001346 mv/v/lb	FULL	1500 LB
82	RIGHT SHOULDER X FORCE (LB)	MICH SCI 4000	5 (Z)	16-Jul-12	13.23 uv/lb at 10V exc				.001323 mv/v/lb	FULL	1500 LB
83	RIGHT SHOULDER Y FORCE (LB)	MICH SCI 4000	5 (Y)	16-Jul-12	14.15 uv/lb at 10V exc				.001415 mv/v/lb	FULL	1500 LB
84	RIGHT SHOULDER Z FORCE (LB)	MICH SCI 4000	5 (X)	16-Jul-12	13.57 uv/lb at 10V exc				.001357 mv/v/lb	FULL	1500 LB

85	LEFT LAP X FORCE (LB)	MICH SCI 4000	2 (Y)	17-Jul-12	13.37 uv/lb at 10V exc				.001337 mv/v/lb	FULL	1500 LB
86	LEFT LAP Y FORCE (LB)	MICH SCI 4000	2 (X)	17-Jul-12	14.15 uv/lb at 10V exc				.001415 mv/v/lb	FULL	1500 LB
87	LEFT LAP Z FORCE (LB)	MICH SCI 4000	2(Z)	17-Jul-12	13.42 uv/lb at 10V exc				.001342 mv/v/lb	FULL	1500 LB
88	RIGHT LAP X FORCE (LB)	MICH SCI 4000	3 (Y)	16-Jul-12	13.51 uv/lb at 10V exc				.001351 mv/v/lb	FULL	1500 LB
89	RIGHT LAP Y FORCE (LB)	MICH SCI 4000	3 (X)	16-Jul-12	14.29 uv/lb at 10V exc				.001429 mv/v/lb	FULL	1500 LB
90	RIGHT LAP Z FORCE (LB)	MICH SCI 4000	3 (Z)	16-Jul-12	13.37 uv/lb at 10V exc				.001337 mv/v/lb	FULL	1500 LB
91	CROTCH X FORCE (LB)	MICH SCI 3000	4335 (Z)	17-Jul-12	12.74 uv/lb at 10V exc				.001274 mv/v/lb	FULL	1500 LB
92	CROTCH Y FORCE (LB)	MICH SCI 3000	4335 (Y)	17-Jul-12	14.91 uv/lb at 10V exc				.001491 mv/v/lb	FULL	1500 LB
93	CROTCH Z FORCE (LB)	MICH SCI 3000	4335 (X)	17-Jul-12	15.51 uv/lb at 10V exc				.001551 mv/v/lb	FULL	1500 LB
94	RT HEADREST Y FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-7588-2	10-Dec-12	8.04 uv/lb at 10V exc	7-Mar-13	8.07 uv/lb at 10V exc	0.4	.000804 mv/v/lb	FULL	2500 LB
95	RT SHOULDER PLATE Y FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-3294-3	20-Aug-12	8.09 uv/lb at 10V exc	7-Mar-13	8.05 uv/lb at 10V exc	-0.5	.000809 mv/v/lb	FULL	2500 LB
96	RT PELVIS Y FORCE (LB)	STRAINSERT FL2.5U-2SGKT	Q-3294-6	16-Aug-12	8.05 uv.lb at 10V exc	14-Mar-13	7.99 uv/lb at 10V exc	-0.7	.000805 mv/vlb	FULL	2500 LB

ATTACHMENT 2: ELECTRONIC DATA CHANNELS (HYBRID III TESTS)

PROGRAM:	TEST DATES:
STUDY NUMBER: 201302 (Hybrid III)	TEST NUMBERS:
FACILITY: HORIZONTAL IMPULSE ACCELERATOR	SAMPLE RATE: 10K
DATA COLLECTION SYSTEM: TDAS PRO	FILTER FREQUENCY:
	TRANSDUCER RANGE (VOLTS): +/- 5V

DATA CHANNEL	DATA POINT	TRANSDUCER MFG. & MODEL	SERIAL NUMBER	PRE-CAL		POST-CAL		% D	DAS SENSITIVITY	BRIDGE	FULL SCALE
				DATE	SENS	DATE	SENS				
1	SLED X ACCEL (G)	ENDEVCO 2262A-200	FR31	20-Nov-12	5.0876 mv/g at 10V exc	04-Mar-13	5.1786 mv/g at 10V exc	1.8	.50876 mv/v/g	FULL	50 G
2	SLED VELOCITY (FT/SEC)	GLOBE IND. 22A672-2	5	20-Nov-12	24.621 mv/ft/sec	19-Mar-13	24.662 mv/ft/sec	1.70	24.621 mv/ft/sec	FULL	100 FT/SEC
3	LEFT HEADREST X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q-3294-1	01-Jun-12	8.07 uv/lb at 10V exc	19-Feb-13	8.04 uv/lb at 10V exc	-0.4	.000807 mv/v/lb	FULL	2500 LB
4	RIGHT HEADREST X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q-3294-2	9-Aug-12	8.00 uv/lb at 10V exc	25-Feb-13	8.04 uv/lb at 10V exc	0.5	.000800 mv/v/lb	FULL	2500 LB
5	CENTER HEADREST X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q-7588-3	10-Dec-12	8.04 uv/lb at 10V exc	27-Feb-13	8.01 uv/lb at 10V exc	-4.0	.000804 mv/v/lb	FULL	2500 LB
6	LEFT UPPER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SGKT	Q19614-4	16-Feb-12	7.95 uv/lb at 10V exc	19-Feb-13	8.01 uv/lb at 10V exc	0.8	.000795 mv/v/lb	FULL	2500 LB
7	RIGHT UPPER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SGKT	Q19614-5	9-Feb-12	7.97 uv/lb at 10V exc	20-Feb-13	7.99 uv/lb at 10V exc	0.3	.000797 mv/v/lb	FULL	2500 LB
8	CENTER UPPER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SGKT	Q19614-6	09-Feb-12	7.98 uv/lb at 10V exc	21-Feb-13	7.93 uv/lb at 10V exc	-0.6	.000798 mv/v/lb	FULL	2500 LB

9	LEFT LOWER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q19614-1	16-Feb-12	7.97 uv/lb at 10V exc	25-Feb-13	7.95 uv/lb at 10V exc	-0.3	.000797 mv/v/lb	FULL	2500 LB
10	RIGHT LOWER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q19614-3	15-Aug-12	7.86 uv/lb at 10V exc	20-Mar-13	7.93 uv/lb at 10V exc	0.9	.000786 mv/v/lb	FULL	2500 LB
11	CENTER LOWER BACK PLATE X FORCE (LB)	STRAINSERT FL2.5-2SPKT	Q19614-2	09-Aug-12	7.94 uv/lb at 10V exc	15-Feb-13	7.93 uv/lb at 10V exc	-0.1	.000794 mv/v/lb	FULL	2500 LB
12	LEFT SEAT PAN Z FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-7135-4	7-Aug-12	7.91 uv/lb at 10V exc	08-Mar-13	7.89 uv/lb at 10V exc	-0.3	.000791 mv/v/lb	FULL	2500 LB
13	RIGHT SEAT PAN Z FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-7135-2	15-Jul-12	7.96 uv/lb at 10V exc	15-Mar-13	7.93 uv/lb at 10V exc	-0.4	.000796 mv/v/lb	FULL	2500 LB
14	CENTER SEAT PAN Z FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q7135-3	17-Aug-12	7.83 uv/lb at 10V exc	8-Mar-13	7.95 uv/lb at 10V exc	1.5	.000783 mv/v/lb	FULL	2500 LB
15	LEFT SHOULDER X FORCE (LB)	MICH SCI 4000	1 (Z)	08-Aug-11	12.86 uv/lb at 10V exc				.001286 mv/v/lb	FULL	1500 LB
16	LEFT SHOULDER Y FORCE (LB)	MICH SCI 4000	1 (Y)	08-Aug-11	13.80 uv/lb at 10V exc				.001380 mv/v/lb	FULL	1500 LB
17	LEFT SHOULDER Z FORCE (LB)	MICH SCI 4000	1 (X)	08-Aug-11	13.46 uv/lb at 10V exc				.001346 mv/v/lb	FULL	1500 LB
18	RIGHT SHOULDER X FORCE (LB)	MICH SCI 4000	5 (Z)	16-Jul-12	13.23 uv/lb at 10V exc				.001323 mv/v/lb	FULL	1500 LB
19	RIGHT SHOULDER Y FORCE (LB)	MICH SCI 4000	5 (Y)	16-Jul-12	14.15 uv/lb at 10V exc				.001415 mv/v/lb	FULL	1500 LB
20	RIGHT SHOULDER Z FORCE (LB)	MICH SCI 4000	5 (X)	16-Jul-12	13.57 uv/lb at 10V exc				.001357 mv/v/lb	FULL	1500 LB
21	LEFT LAP X FORCE (LB)	MICH SCI 4000	2 (Y)	17-Jul-12	13.37 uv/lb at 10V exc				.001337 mv/v/lb	FULL	1500 LB

22	LEFT LAP Y FORCE (LB)	MICH SCI 4000	2 (X)	17-Jul-12	14.15 uv/lb at 10V exc				.001415 mv/v/lb	FULL	1500 LB
23	LEFT LAP Z FORCE (LB)	MICH SCI 4000	2(Z)	17-Jul-12	13.42 uv/lb at 10V exc				.001342 mv/v/lb	FULL	1500 LB
24	RIGHT LAP X FORCE (LB)	MICH SCI 4000	3 (Y)	16-Jul-12	13.51 uv/lb at 10V exc				.001351 mv/v/lb	FULL	1500 LB
25	RIGHT LAP Y FORCE (LB)	MICH SCI 4000	3 (X)	16-Jul-12	14.29 uv/lb at 10V exc				.001429 mv/v/lb	FULL	1500 LB
26	RIGHT LAP Z FORCE (LB)	MICH SCI 4000	3 (Z)	16-Jul-12	13.37 uv/lb at 10V exc				.001337 mv/v/lb	FULL	1500 LB
27	CROTCH X FORCE (LB)	MICH SCI 3000	4335 (X)	17-Jul-12	15.51 uv/lb at 10V exc				.001551 mv/v/lb	FULL	1500 LB
28	CROTCH Y FORCE (LB)	MICH SCI 3000	4335 (Y)	17-Jul-12	14.91 uv/lb at 10V exc				.001491 mv/v/lb	FULL	1500 LB
29	CROTCH Z FORCE (LB)	MICH SCI 3000	4335 (Z)	17-Jul-12	12.74 uv/lb at 10V exc				.001274 mv/v/lb	FULL	1500 LB
30	RT HEADREST Y FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-7588-2	10-Dec-12	8.04 uv/lb at 10V exc	7-Mar-13	8.07 uv/lb at 10V exc	0.4	.000804 mv/v/lb	FULL	2500 LB
31	RT SHOULDER PLATE Y FORCE (LB)	STRAINSERT FL2.5U-2SPKT	Q-3294-3	20-Aug-12	8.09 uv/lb at 10V exc	07-Mar-13	8.05 uv/lb at 10V exc	-0.5	.000809 mv/v/lb	FULL	2500 LB
32	RT PELVIS Y FORCE (LB)	STRAINSERT FL2.5U-2SGKT	Q-3294-6	16-Aug-12	8.05 uv.lb at 10V exc	14-Mar-13	7.99 uv/lb at 10V exc	-0.7	.000805 mv/vlb	FULL	2500 LB
33	RIGHT KNEE FORCE (LB)	STRAINSERT FL2.5-2SGKT	Q-7588-1	19-Dec-12	7.99 uv/lb at 10V exc	27-Feb-13	7.99 uv/lb at 10V exc	0.00	.000799 mv/v/lb	FULL	2500 LB
35	INT HEAD X ACCEL (G)	ENDEVCO 7264C-500	P11261	11-Jul-12	.6948 mv/g at 10V exc	12-Mar-13	.6991 mv/g at 10V exc	0.6	.06948 mv/v/g	FULL	100 G
35	INT HEAD X ACCEL (G)	ENDEVCO 7264C-500	P11259	31-Dec-12	.7330 mv/g at 10V exc	12-Mar-13	.7285 mv/g at 10V exc	-0.6	.07330 mv/v/g	FULL	100 G
36	INT HEAD Y ACCEL (G)	ENDEVCO 7264C-500	P11262	11-Jul-12	.6920 mv/g at 10V exc	12-Mar-13	.6957 mv/g at 10V exc	0.5	.06920 mv/v/g	FULL	100 G
37	INT HEAD Z ACCEL (G)	ENDEVCO 7264C-500	P11263	11-Jul-12	.7098 mv/g at 10V exc	12-Mar-13	.7127 mv/g at 10V exc	0.4	.07098 mv/v/g	FULL	100 G

38	INT HEAD Ry ANG ACCEL (RAD/SEC2)	ENDEVCO 7302B	10178	11-Jul-12	3.38 uv/rad/sec2 at 10V exc	13-Mar-13	3.35 uv/rad/sec2 at 10V exc	-0.7	.000338 mv/v/rad/sec2	FULL	5000 RAD/SEC2
39	INT NECK X FORCE (LB)	DENTON 1716A	473	12-Jul-12	8.14 uvlb at 10V exc	14-Mar-13	8.19 uv/lb at 10V exc	0.6	.000814 mv/v/g	FULL	2000 LB
40	INT NECK Y FORCE (LB)	DENTON 1716A	473	12-Jul-12	8.38 uv/lb at 10V exc	14-Mar-13	8.33 uv/lb at 10V exc	-0.6	.000838 mv/v/lb	FULL	2000 LB
41	INT NECK Z FORCE (LB)	DENTON 1716A	473	12-Jul-12	4.40 uv/lb at 10V exc	14-Mar-13	4.37 uv/lb at 10V exc	-0.7	.000440 mv/v/lb	FULL	3000 LB
42	INT NECK Mx TORQUE (IN-LB)	DENTON 1716A	473	12-Jul-12	6.65 uv/in-lb at 10V exc	14-Mar-13	6.63 uv/in-lb at 10V exc	-0.3	.000665 mv/v/in-lb	FULL	2500 IN-LB
43	INT NECK My TORQUE (IN-LB)	DENTON 1716A	473	12-Jul-12	6.68 uv/in-lb at 10V exc	14-Mar-13	6.66 uv/in-lb at 10V exc	-0.3	.000668 mv/v/in-lb	FULL	2500 IN-LB
44	INT NECK Mz TORQUE (IN-LB)	DENTON 1716A	473	12-Jul-12	8.98 uv/in-lb at 10V exc	14-Mar-13	9.02 uv/in-lb at 10V exc	0.4	.000898 mv/v/in-lb	FULL	2500 IN-LB
45	INT CHEST X ACCEL (G)	ENDEVCO 7264C-500	P11266	11-Jul-12	.7712 mv/g at 10V exc	12-Mar-13	.7760 mv/g at 10V exc	0.6	.07712 mv/v/g	FULL	100 G
46	INT CHEST Y ACCEL (G)	ENDEVCO 7264C-500	P11265	11-Jul-12	.7002 mv/g at 10V exc	12-Mar-13	.7036 mv/g at 10V exc	0.5	.07002 mv/v/g	FULL	100 G
47	INT CHEST Z ACCEL (G)	ENDEVCO 7264C-500	P11264	11-Jul-12	.7443 mv/g at 10V exc	12-Mar-13	.7494 mv/g at 10V exc	0.7	.07443 mv/v/g	FULL	100 G
48	INT CHEST Ry ANG ACCEL (RAD/SEC2)	ENDEVCO 7302B	10173	22-Feb-12	3.23 uv/rad/sec2 at 10V exc	13-Mar-13	3.23 uv/rad/sec2 at 10V exc	-0.1	.000323 mv/v/rad/sec2	FULL	5000 RAD/SEC2
49	INT LUMBAR X ACCEL (G)	ENTRAN EGV3-F-250	Y1117L (X)	23-Nov-12	.5930 mv/g at 10V exc	12-Mar-13	.5995 mv/g at 10V exc	1.1	.05930 mv/v/g	FULL	100 G
50	INT LUMBAR Y ACCEL (G)	ENTRAN EGV3-F-250	Y1117L (Y)	23-Nov-12	.6420 mv/g at 10V exc	12-Mar-13	6516 mv/g at 10V exc	1.5	.06420 mv/v/g	FULL	100 G
51	INT LUMBAR Z ACCEL (G)	ENTRAN EGV3-F-250	Y1117L (Z)	23-Nov-12	.8275 mv/g at 10V exc	12-Mar-13	.8326 mv/g at 10V exc	0.6	.08275 mv/v/g	FULL	100 G
52	INT LUMBAR X FORCE (LB)	DENTON 1914A	503	12-Jul-12	6.56 uv/lb at 10V exc	19-Mar-13	6.54 uv/lb at 10V exc	-0.3	.000656 mv/v/lb	FULL	3000 LB
53	INT LUMBAR Y FORCE (LB)	DENTON 1914A	503	12-Jul-12	6.56 uv/lb at 10V exc	19-Mar-13	6.55 uv/lb at 10V exc	-0.2	.000656 mv/v/lb	FULL	3000 LB

54	INT LUMBAR Z FORCE (LB)	DENTON 1914A	503	12-Jul-12	2.69 uv/lb at 10V exc	19-Mar-13	2.69 uv/lb at 10V exc	0.0	.000269 mv/v/lb	FULL	5000 LB
55	INT LUMBAR Mx TORQUE (IN-LB)	DENTON 1914A	503	12-Jul-12	5.12 uv/in-lb at 10V exc	19-Mar-13	5.09 uv/in-lb at 10V exc	-0.6	.000512 mv/v/in-lb	FULL	3000 IN-LB
56	INT LUMBAR My TORQUE (IN-LB)	DENTON 1914A	503	12-Jul-12	5.11 uv/in-lb at 10V exc	19-Mar-13	5.09 uv/in-lb at 10V exc	-0.4	.000511 mv/v/in-lb	FULL	3000 IN-LB
57	INT LUMBAR Mz TORQUE (IN-LB)	DENTON 1914A	503	12-Jul-12	8.44 uv/in-lb at 10V exc	19-Mar-13	8.38 uv/in-lb at 10V exc	-0.7	.000844 mv/v/in-lb	FULL	3000 IN-LB
58	INT LOWER NECK X FORCE (LB)	DENTON 1794AJTF	282	03-Dec-12	6.29 uv/lb at 10V exc				.000629 mv/v/lb	FULL	3000 LB
59	INT LOWER NECK Y FORCE (LB)	DENTON 1794AJTF	282	03-Dec-12	6.28 uv/lb at 10V exc				.000628 mv/v/lb	FULL	3000 LB
60	INT LOWER NECK Z FORCE (LB)	DENTON 1794AJTF	282	03-Dec-12	3.17 uv/lb at 10V exc				.000317 mv/v/lb	FULL	3000 LB
61	INT LOWER NECK Mx TORQUE (IN-LB)	DENTON 1794AJTF	282	03-Dec-12	4.39 uv/in-lb at 10V exc				.000439 mv/v/in-lb	FULL	4000 IN-LB
62	INT LOWER NECK Mx TORQUE (IN-LB)	DENTON 1794AJTF	282	03-Dec-12	4.21 uv/in-lb at 10V exc				.000421 mv/v/in-lb	FULL	4000 IN-LB
63	INT LOWER NECK Mx TORQUE (IN-LB)	DENTON 1794AJTF	282	03-Dec-12	7.70 uv/in-lb at 10V exc				.000770 mv/v/in-lb	FULL	4000 IN-LB

ATTACHMENT 3: REPRESENTATIVE DATA PRINT-OUTS (+Z-AXIS)

+Z-Axis Data Examples for THOR-K:	Test 8658: Cell A1, 10 G, 40ms time-to-peak
	Test 8667: Cell E3, 10 G, 70ms time-to-peak
	Test 8669: Cell E4, 20 G, 70ms time-to-peak

201302 Test: 8658 Test Date: 130122 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: A1

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
Reference Mark Time (Ms)				4.4	
Impact Rise Time (Ms)				33.8	
Impact Duration (Ms)				97.7	
Velocity Change (Ft/Sec)		19.12			
SLED X ACCEL (G)	0.00	10.01	-0.59	33.8	238.1
SLED VELOCITY (FT/SEC)	-0.08	18.20	-0.07	101.7	0.0
INTEGRATED ACCEL (FT/SEC)	0.01	19.12	0.02	97.6	0.0
LEFT HEADREST X FORCE (LB)	6.21	520.62	-80.54	207.4	42.8
RIGHT HEADREST X FORCE (LB)	8.42	392.42	-62.92	207.3	41.2
CT HEADREST X FORCE (LB)	-8.45	29.52	-138.29	24.2	207.2
HEADREST X SUM (LB)	6.17	775.64	-118.61	207.4	42.1
LF UPPER BACK X FORCE (LB)	25.60	129.81	-17.68	59.8	87.6
RT UPPER BACK X FORCE (LB)	39.23	145.74	-15.38	60.5	117.4
CT UPPER BACK X FORCE (LB)	6.98	38.21	-76.41	221.5	61.4
UPPER BACKPLATE X SUM (LB)	71.81	207.39	-43.09	59.8	87.6
LF LOWER BACK X FORCE (LB)	25.44	172.44	-34.70	105.0	40.2
RT LOWER BACK X FORCE (LB)	29.43	245.15	-13.04	50.6	209.3
CT LOWER BACK X FORCE (LB)	29.19	357.71	18.66	55.4	117.5
LOWER BACKPLATE X SUM (LB)	84.06	697.16	50.89	55.1	209.4
LEFT SEAT PAN Z FORCE (LB)	5.76	419.89	-54.99	58.3	214.8
RIGHT SEAT PAN Z FORCE (LB)	3.68	450.81	-76.24	57.6	215.3
CENTER SEAT PAN Z FORCE (LB)	17.45	1735.41	-36.70	55.9	217.9
SEAT PAN Z SUM (LB)	26.89	2584.21	-146.76	56.0	217.7
SEAT PAN Z MINUS TARE (LB)	26.85	2790.37	-155.27	55.9	217.7
LEFT SHOULDER X FORCE (LB)	-8.27	3.96	-45.77	209.9	159.0
LEFT SHOULDER Y FORCE (LB)	2.55	7.19	-6.12	210.2	211.9
LEFT SHOULDER Z FORCE (LB)	4.28	26.52	-3.36	44.9	214.3
LEFT SHOULDER RES (LB)	9.67	46.16	0.89	159.0	109.1
RIGHT SHOULDER X FORCE (LB)	-15.68	-0.89	-54.59	209.9	155.3
RIGHT SHOULDER Y FORCE (LB)	-2.72	2.12	-9.57	211.8	209.4
RIGHT SHOULDER Z FORCE (LB)	2.64	31.99	-7.14	68.0	216.7
RIGHT SHOULDER RES (LB)	16.15	55.11	3.05	155.3	104.5
LEFT LAP X FORCE (LB)	-11.41	14.85	-97.25	45.2	162.7
LEFT LAP Y FORCE (LB)	-1.78	16.79	-31.80	42.8	41.7
LEFT LAP Z FORCE (LB)	-4.62	13.74	-53.53	44.2	162.4

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201302 Test: 8658 Test Date: 130122 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: A1

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
LEFT LAP RESULTANT (LB)	12.46	110.89	1.54	162.5	84.5
RIGHT LAP X FORCE (LB)	-9.82	17.25	-99.60	37.7	161.1
RIGHT LAP Y FORCE (LB)	1.54	19.42	-13.39	89.8	167.2
RIGHT LAP Z FORCE (LB)	-10.59	4.85	-61.83	33.1	164.0
RIGHT LAP RESULTANT (LB)	14.54	117.60	4.53	161.0	18.7
CROTCH STRAP X FORCE (LB)	1.63	36.58	-28.41	158.5	41.2
CROTCH STRAP Y FORCE (LB)	-3.09	2.01	-7.55	20.3	154.7
CROTCH STRAP Z FORCE (LB)	-11.86	18.36	-122.66	42.1	159.0
CROTCH STRAP FORCE (LB)	12.38	127.67	2.12	159.0	93.6
RIGHT HEADREST Y FORCE (LB)	-18.61	-6.18	-29.51	375.9	245.7
RT SHOULDER PLATE Y (LB)	-3.32	6.57	-18.48	130.5	472.2
RIGHT PELVIS PLATE Y FORCE (LB	-4.78	9.44	-14.22	311.4	162.8
INT HEAD X ACCEL (G)	1.00	61.96	-3.04	207.2	117.3
INT HEAD Y ACCEL (G)	0.00	2.65	-1.84	212.9	208.7
INT HEAD Z ACCEL (G)	0.00	26.06	-12.78	58.1	209.3
INT HEAD RESULTANT (G)	1.00	62.03	0.07	207.1	357.0
INT HEAD HIC		78.20		204.9	209.7
INT HEAD Rx ANG (RAD/SEC2)	-2.42	203.87	-156.38	59.4	101.7
INT HEAD Ry ANG (RAD/SEC2)	0.51	495.21	-465.46	97.7	202.7
INT HEAD Rz ANG (RAD/SEC2)	0.84	100.36	-110.05	100.3	186.0
INT NECK X FORCE (LB)	-13.34	3.16	-62.06	202.4	116.9
INT NECK Y FORCE (LB)	-1.30	6.02	-34.67	137.6	66.3
INT NECK Z FORCE (LB)	4.73	288.37	-311.72	208.6	57.3
INT NECK RESULTANT (LB)	14.24	313.87	0.45	57.3	300.8
INT NECK Mx TORQUE (IN-LB)	-8.69	23.84	-119.82	147.1	65.7
INT NECK My TORQUE (IN-LB)	5.74	53.85	-9.54	117.6	202.7
INT NECK Mz TORQUE (IN-LB)	-1.79	10.08	-13.40	21.0	213.9
INT NECK TORQUE RES (IN-LB)	10.58	120.04	0.99	65.7	178.4
INT LOWER NECK X FORCE (LB)	-8.73	60.77	-41.60	60.9	147.5
INT LOWER NECK Y FORCE (LB)	-4.69	5.28	-26.49	62.2	53.9
INT LOWER NECK Z FORCE (LB)	-1.78	293.94	-398.58	208.9	57.4
INT LOWER NECK RES (LB)	10.12	402.04	2.89	57.9	298.6
INT LOWER NECK Mx (IN-LB)	-17.07	60.23	-183.39	138.9	71.4
INT LOWER NECK My (IN-LB)	64.19	319.93	-97.32	122.6	61.7
INT LOWER NECK Mz (IN-LB)	-0.46	29.89	-35.59	146.3	71.0

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201302 Test: 8658 Test Date: 130122 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: A1

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT LOWER NECK RES (IN-LB)	66.43	323.12	6.83	122.2	312.8
INT NECK SPRING FRONT FORCE (	-14.75	-8.72	-20.99	202.6	106.7
INT NECK SPRING REAR FORCE (L	3.51	35.74	-6.64	132.5	67.5
INT OC Ry ANGLE (DEG)	89.08	90.69	88.10	87.1	71.0
INT UPPER LT THORAX DX (MM)	81.57	83.50	80.73	94.1	209.4
INT UPPER LT THORAX RY (DEG)	4.53	6.13	-0.33	130.5	64.0
INT UPPER LT THORAX RZ (DEG)	7.59	8.25	6.92	140.4	68.5
INT UPPER RT THORAX DX (MM)	83.72	85.45	83.05	94.5	201.4
INT UPPER RT THORAX RY (DEG)	4.02	6.15	-0.09	102.7	65.6
INT UPPER RT THORAX RZ (DEG)	-13.36	-12.42	-14.01	135.6	67.6
INT LOWER LT THORAX DX (MM)	127.63	128.76	112.80	14.3	64.9
INT LOWER LT THORAX RY (DEG)	17.86	17.99	8.36	17.0	73.1
INT LOWER LT THORAX RZ (DEG)	5.24	6.83	4.97	73.9	117.3
INT LOWER RT THORAX DX (MM)	122.85	123.84	110.45	26.9	70.4
INT LOWER RT THORAX RY (DEG)	18.76	18.79	10.00	15.8	70.5
INT LOWER RT THORAX RZ (DEG)	-10.31	-9.62	-10.94	76.8	60.6
INT LEFT CLAVICLE MFX (LB)	1.27	7.04	-1.59	152.4	108.4
INT LEFT CLAVICLE MFZ FORCE (L	1.83	4.00	-5.08	116.9	62.1
INT LEFT CLAVICLE LFX FORCE (LB	-0.69	2.84	-5.17	82.4	154.2
INT LEFT CLAVICLE LFZ FORCE (LB	-1.68	3.36	-3.58	58.4	117.1
INT STERNUM X ACCEL (G)	1.00	59.09	-29.28	60.4	61.8
INT T1 X ACCEL (G)	0.99	6.39	-8.09	209.8	70.9
INT T1 Y ACCEL (G)	0.00	6.37	-3.92	52.3	57.5
INT T1 Z ACCEL (G)	0.00	26.56	-3.79	54.7	212.0
INT T2 X ACCEL (G)	1.00	6.82	-3.08	55.1	41.5
INT T2 Y ACCEL (G)	0.00	5.35	-3.13	60.7	55.6
INT T2 Z ACCEL (G)	0.00	25.99	-3.56	56.2	211.6
INT CHEST X ACCEL (G)	1.01	8.40	-2.67	55.3	211.0
INT CHEST Y ACCEL (G)	0.00	4.62	-3.08	60.8	53.1
INT CHEST Z ACCEL (G)	0.00	25.30	-3.10	55.1	148.4
INT CHEST RESULTANT (G)	1.01	26.64	0.43	55.1	248.2
INT THORAX SPINE X FORCE (LB)	13.15	586.94	-65.59	58.2	210.3
INT THORAX SPINE Y FORCE (LB)	1.43	19.68	-66.55	98.9	61.9
INT THORAX SPINE Z FORCE (LB)	54.17	75.97	-118.80	42.7	61.5
INT THORAX SPINE Mx (IN-LB)	-31.19	132.34	-185.64	67.5	53.2
INT THORAX SPINE My (IN-LB)	105.50	646.71	-6.11	72.8	210.8

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201302 Test: 8658 Test Date: 130122 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: A1

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT RIGHT ACETABULAR X (LB)	-13.50	23.46	-100.74	89.1	78.1
INT RIGHT ACETABULAR Y (LB)	-0.54	30.16	-37.68	53.1	160.6
INT RIGHT ACETABULAR Z (LB)	13.02	59.06	-41.76	158.5	63.6
INT PELVIS X ACCEL (G)	1.32	4.80	-3.38	102.2	56.6
INT PELVIS Y ACCEL (G)	-0.24	3.49	-1.23	60.7	65.6
INT PELVIS Z ACCEL (G)	0.31	9.75	-26.41	141.7	54.0
INT PELVIS RESULTANT (G)	1.38	26.60	0.69	54.0	112.7
INT LEFT ANKLE RX (DEG)	2.17	7.61	-2.72	103.8	206.9
INT LEFT ANKLE Ry (DEG)	3.48	8.80	-3.34	144.2	341.1
INT LEFT ANKLE Rz (DEG)	-278.84	-164.83	-293.59	329.1	67.8
INT RIGHT ANKLE Rx (DEG)	0.70	3.81	-4.89	362.9	90.3
INT RIGHT ANKLE Ry (DEG)	1.22	2.93	-0.27	135.6	40.8
INT RIGHT ANKLE Rz (DEG)	44.65	49.72	42.94	470.6	160.5

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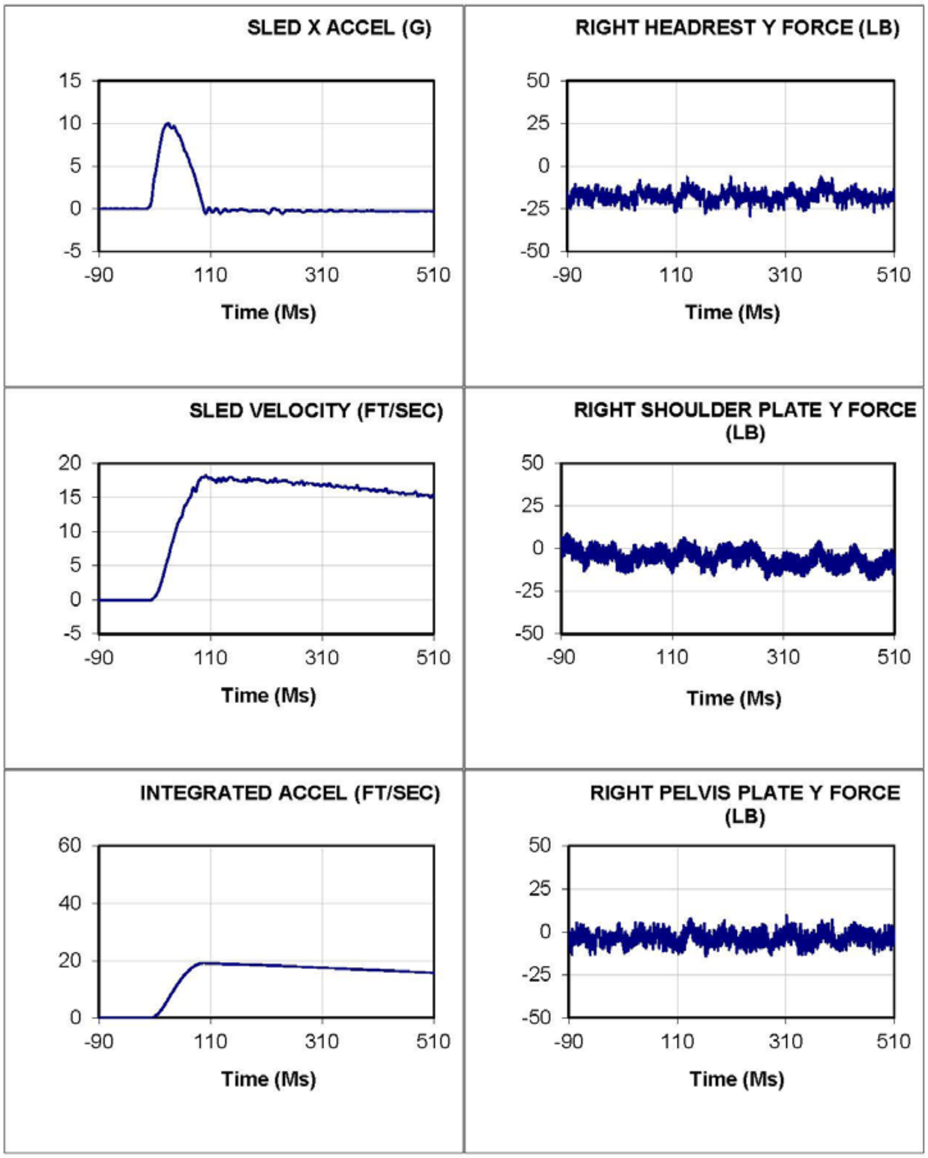
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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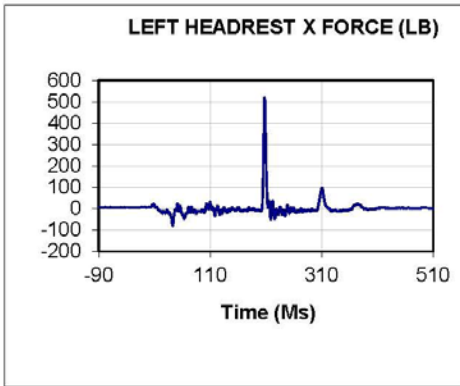
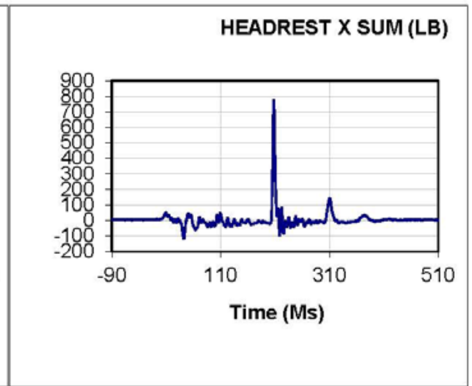
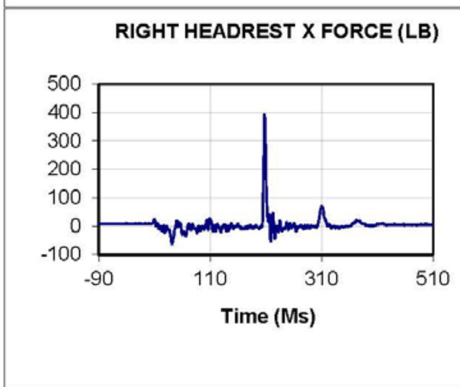
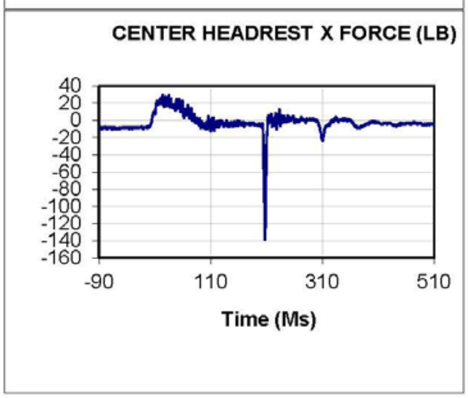
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1









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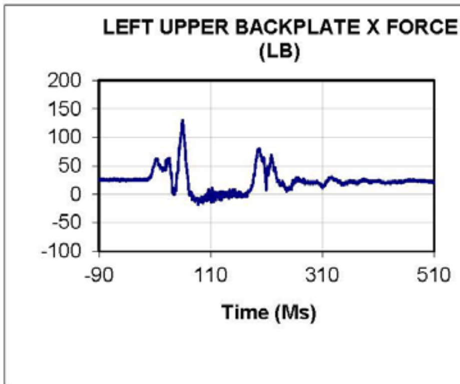
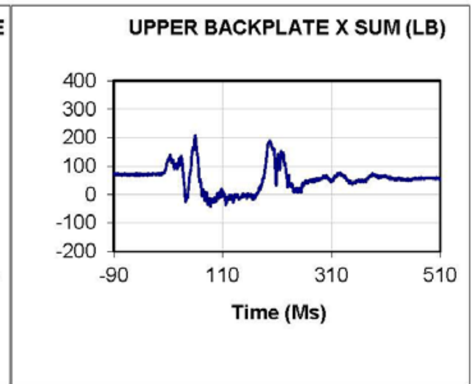
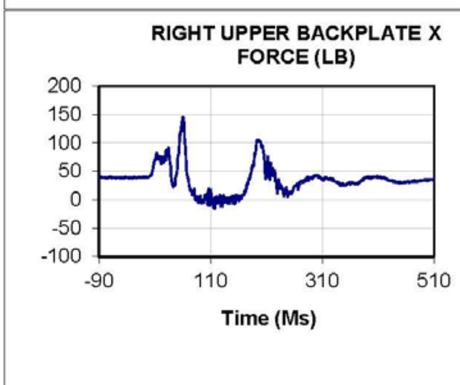
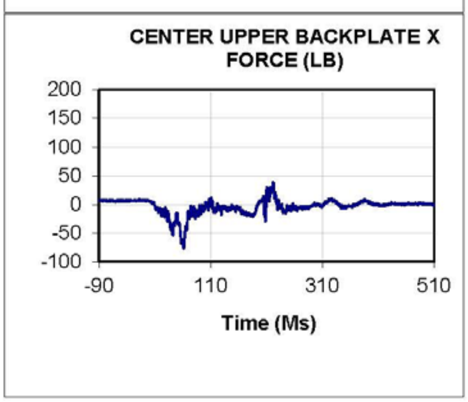
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1









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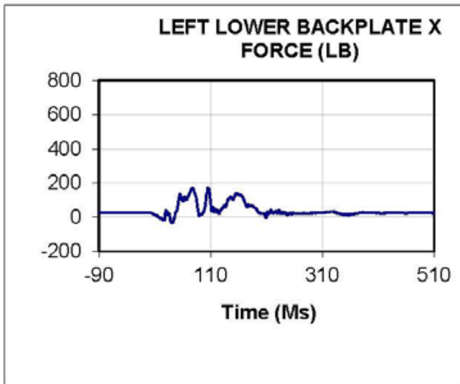
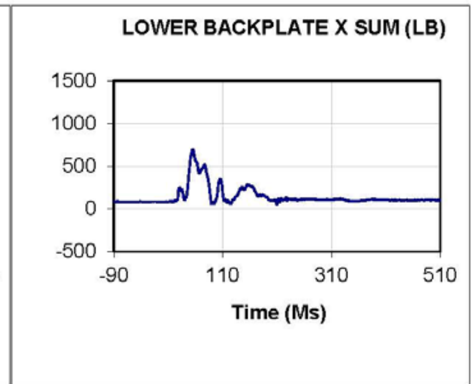
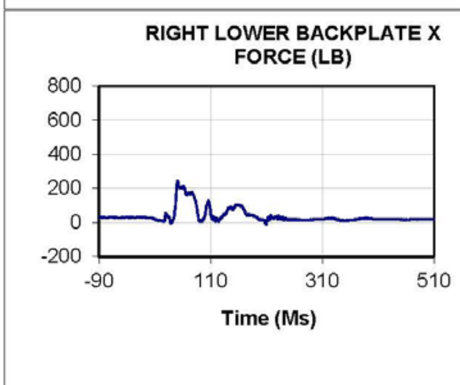
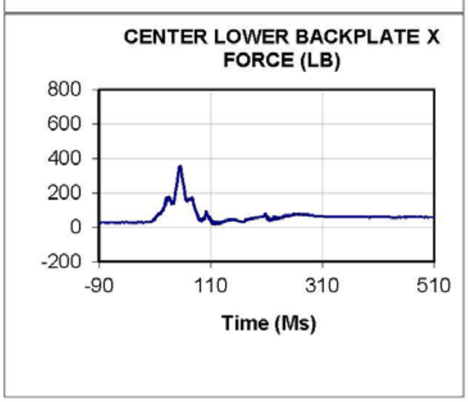
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1









Distribution A: Approved for public release; distribution unlimited.
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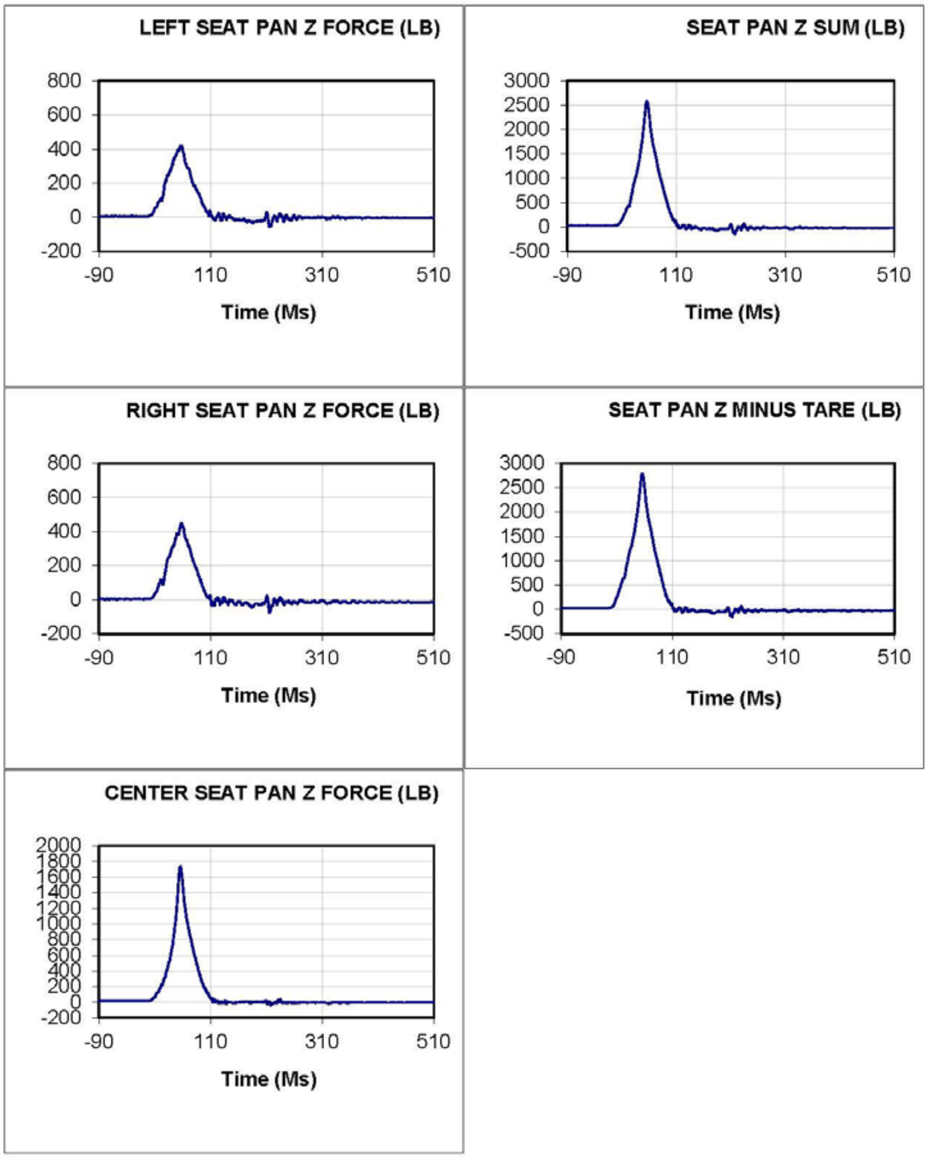
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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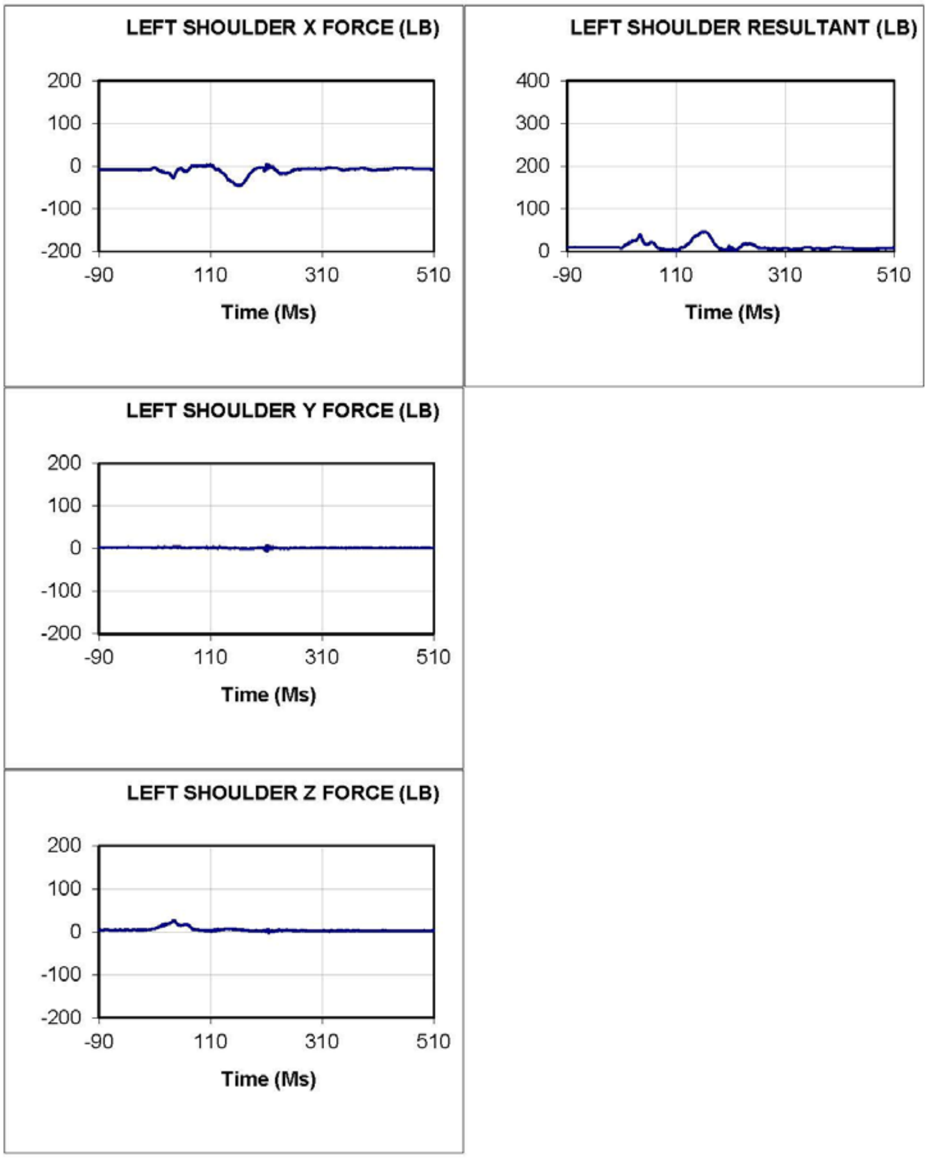
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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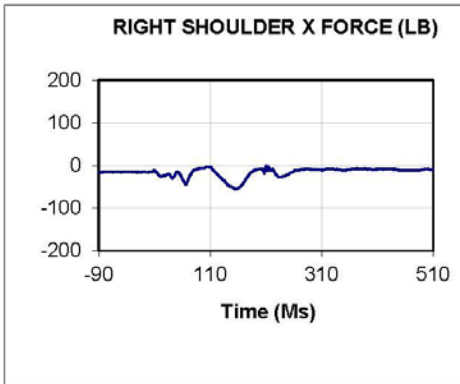
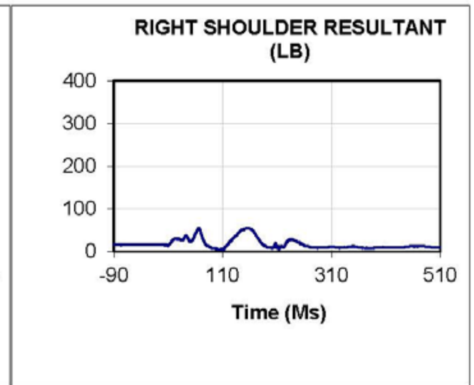
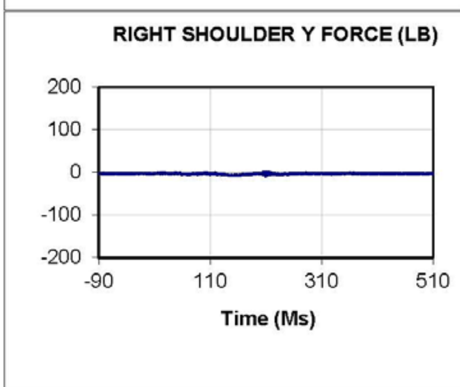
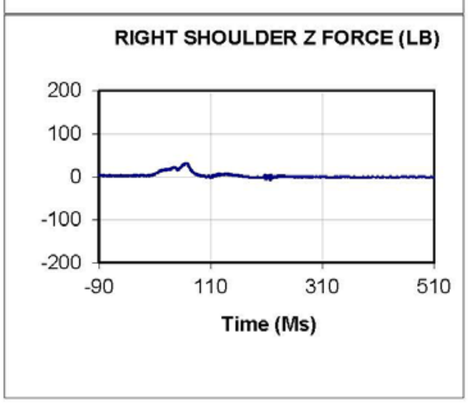
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1

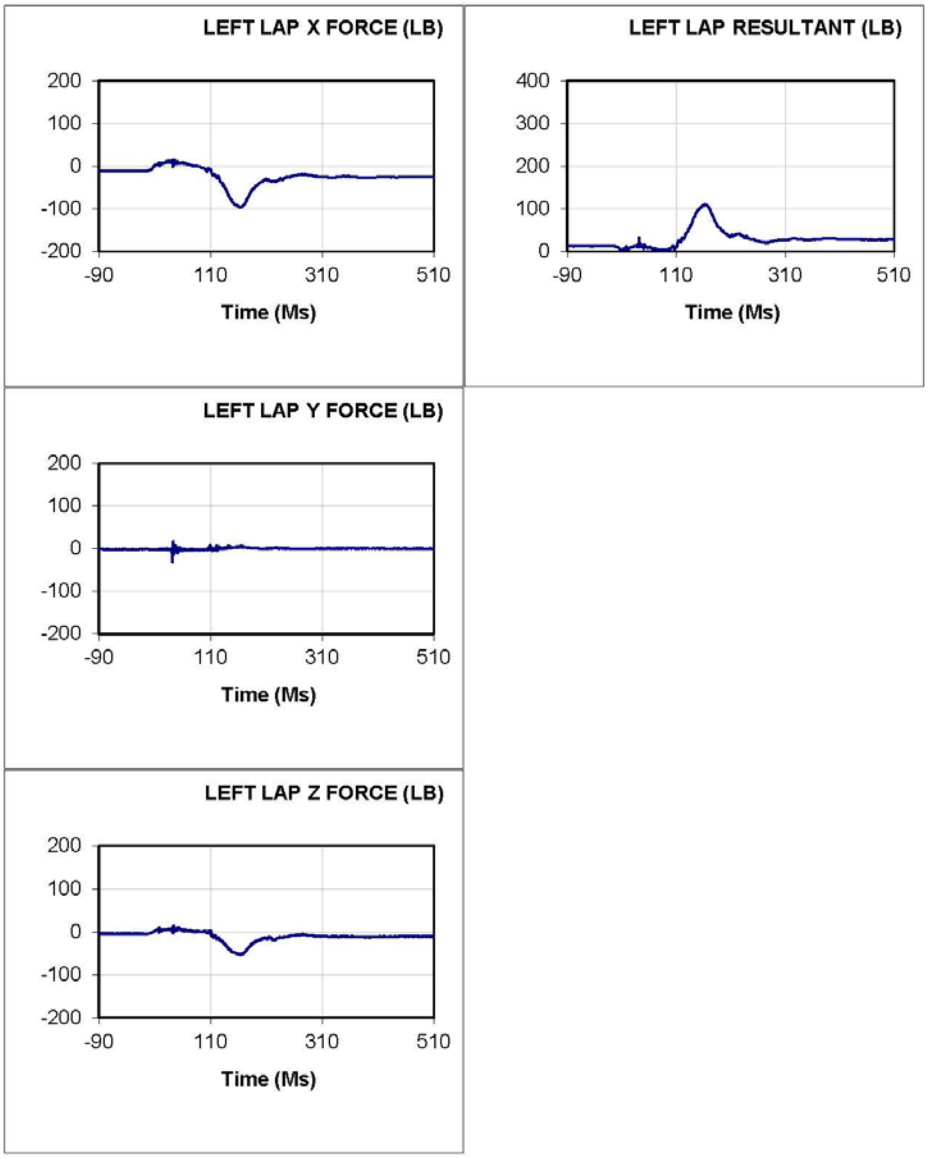








201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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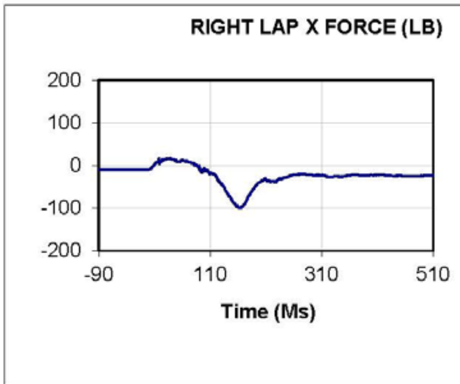
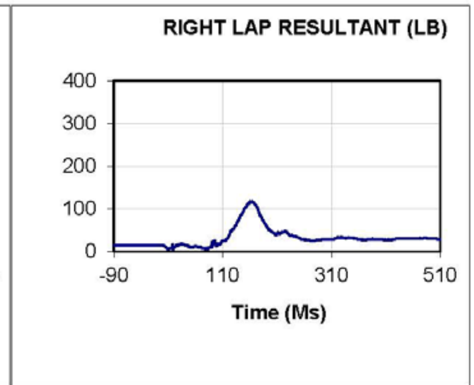
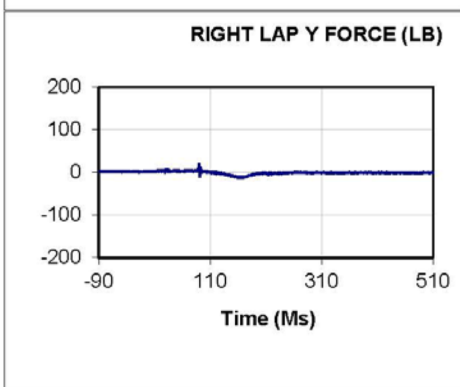
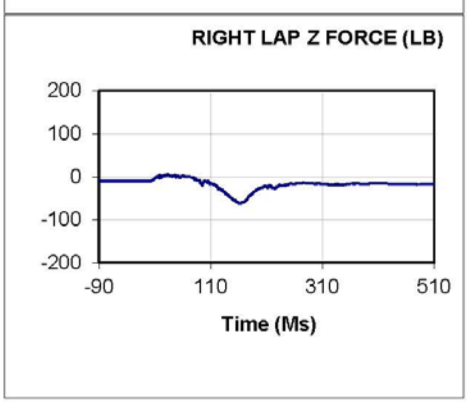
Distribution A: Approved for public release; distribution unlimited.
88 ABW/PA Cleared 02/12/2014; 88ABW-2014-0506.

201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1

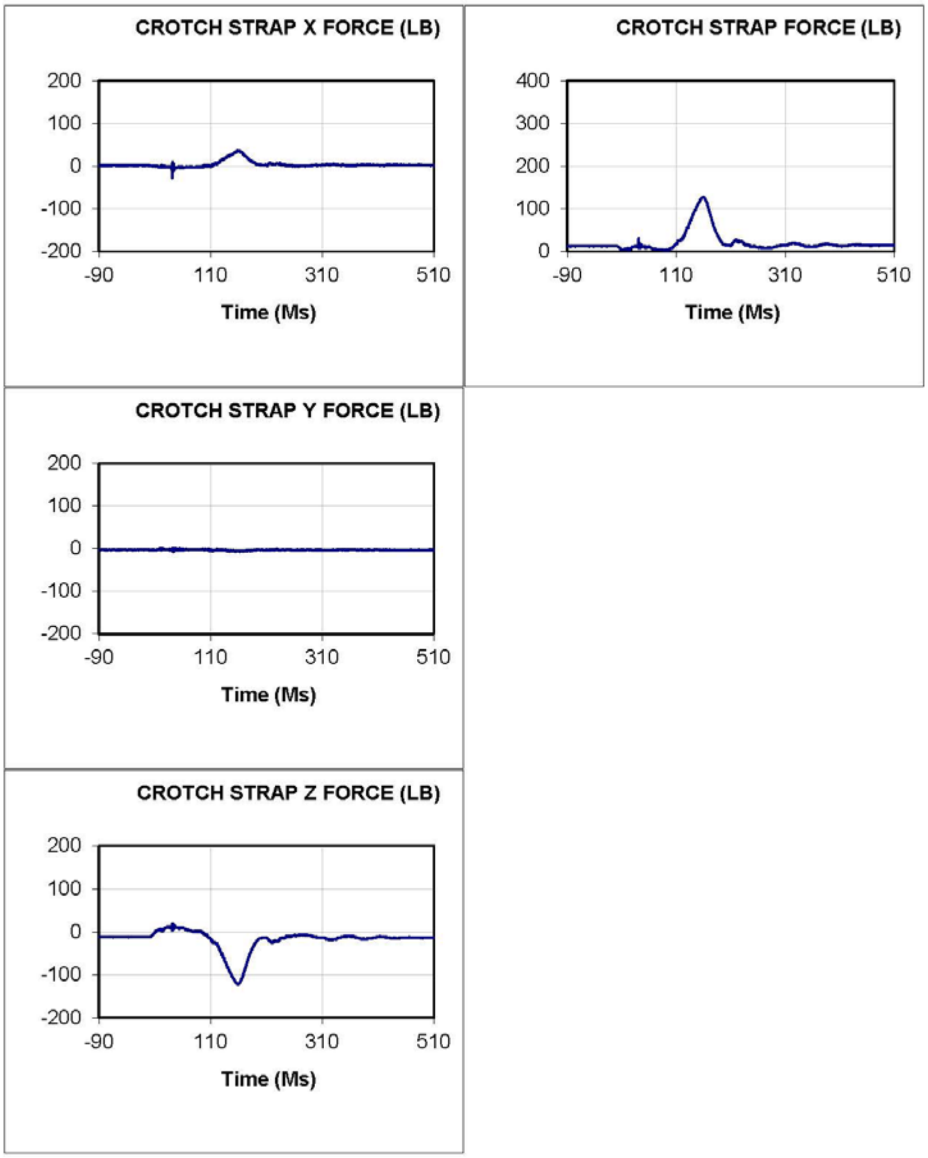








201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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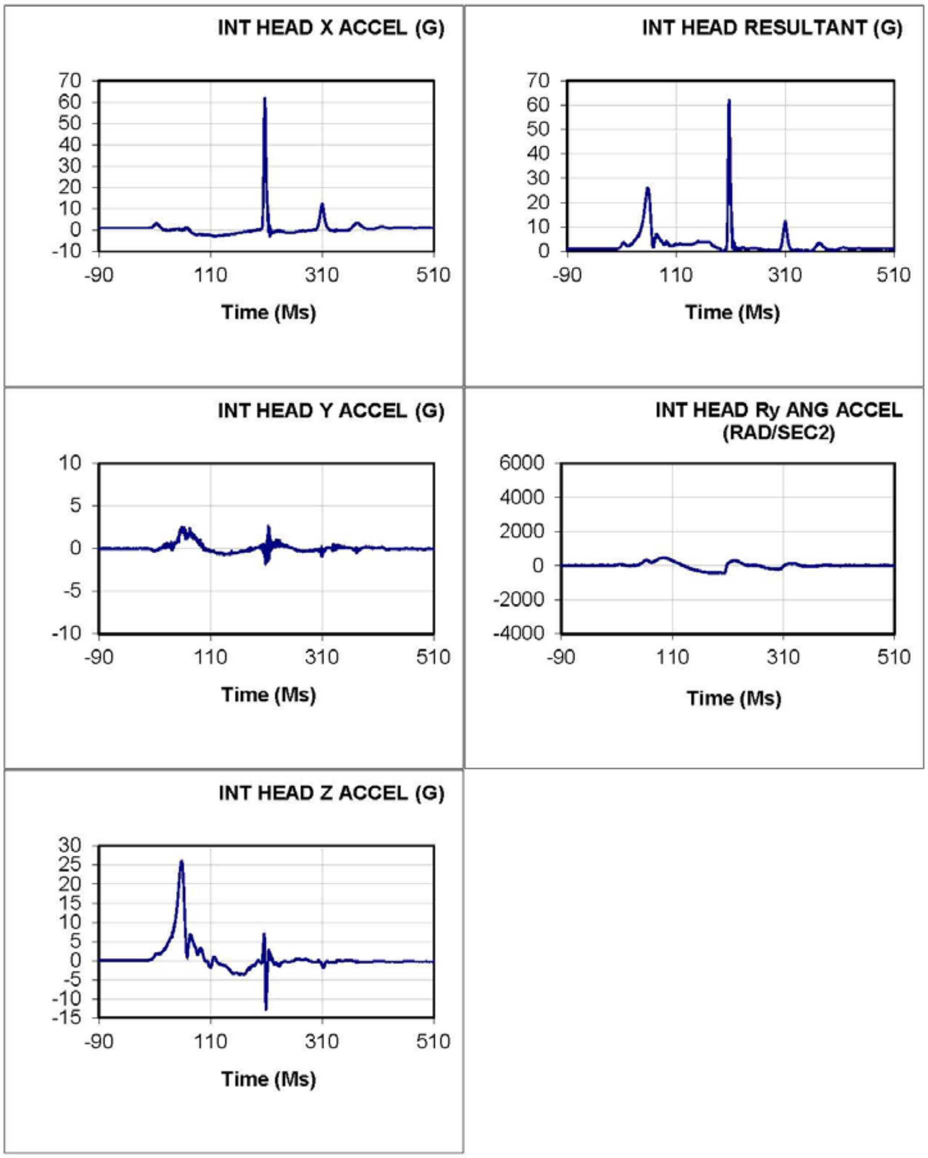
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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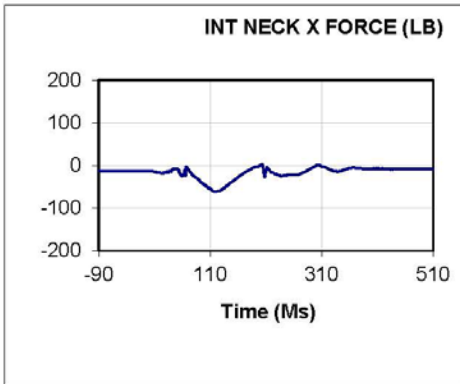
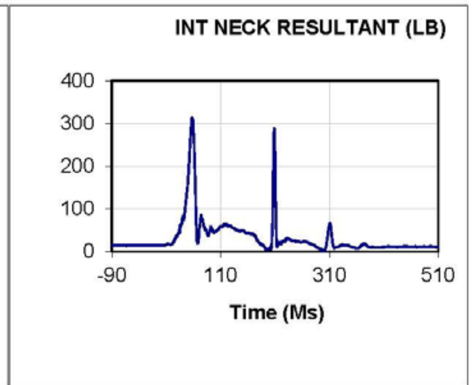
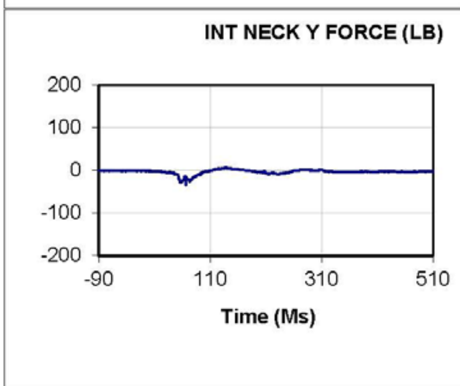
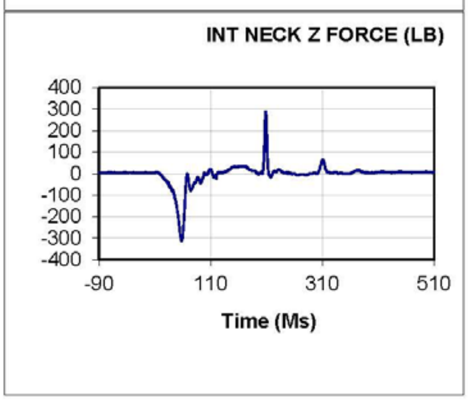
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1









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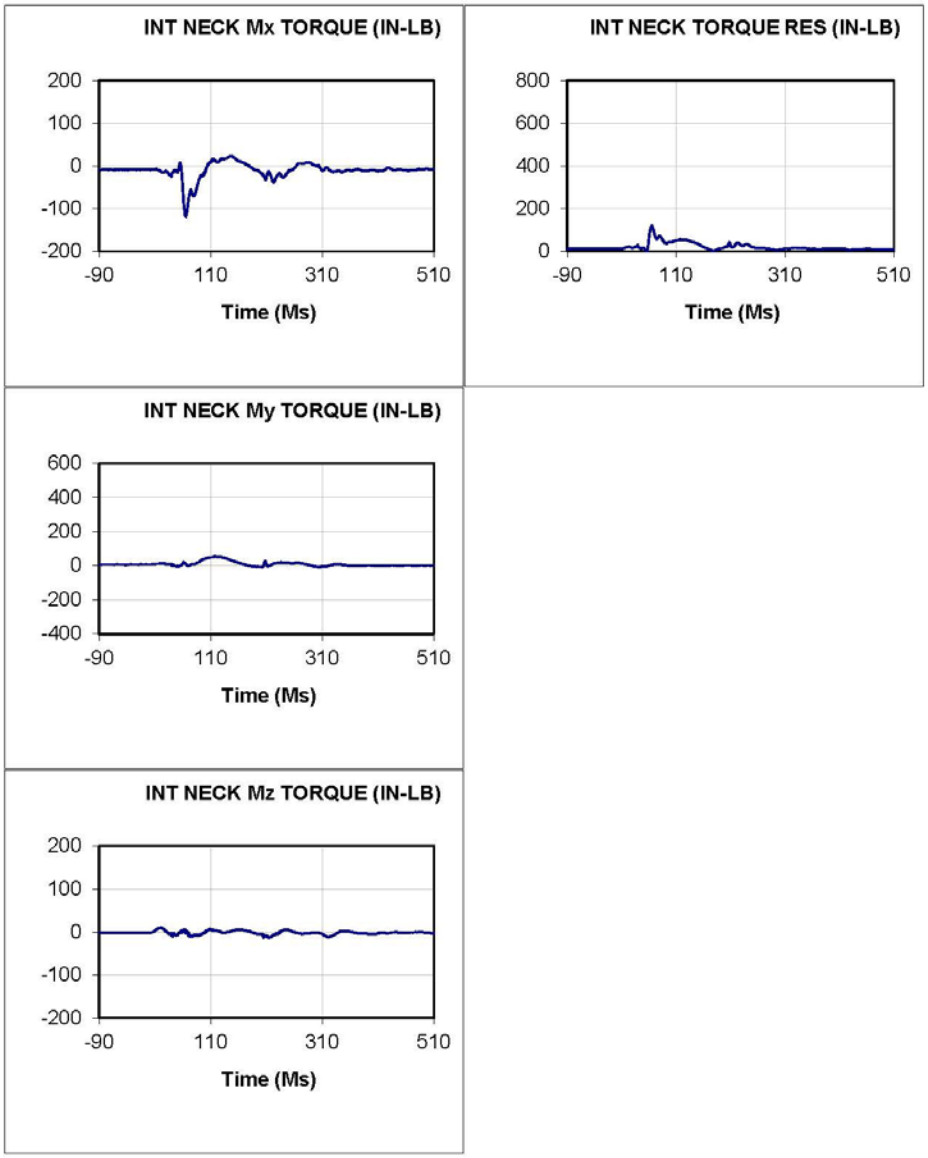
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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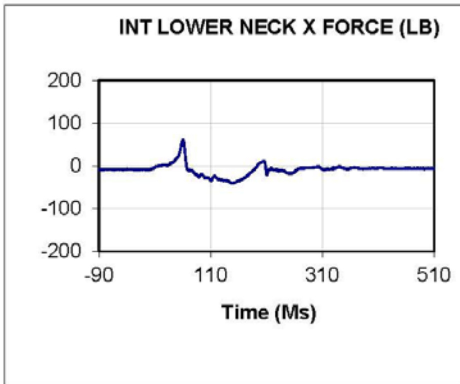
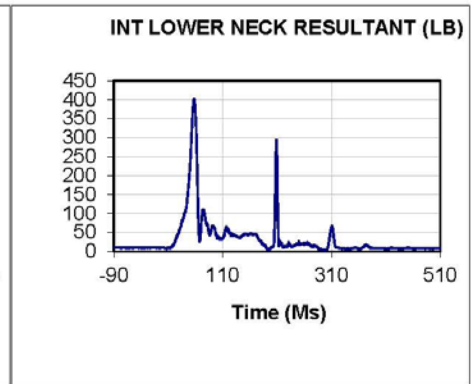
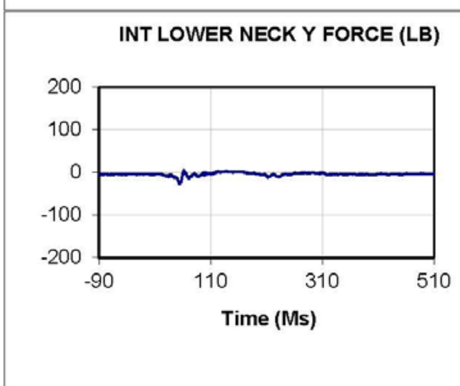
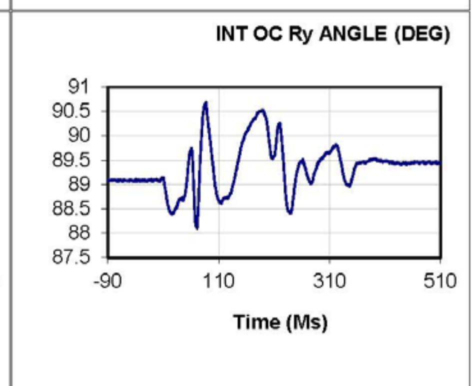
Distribution A: Approved for public release; distribution unlimited.
88 ABW/PA Cleared 02/12/2014; 88ABW-2014-0506.

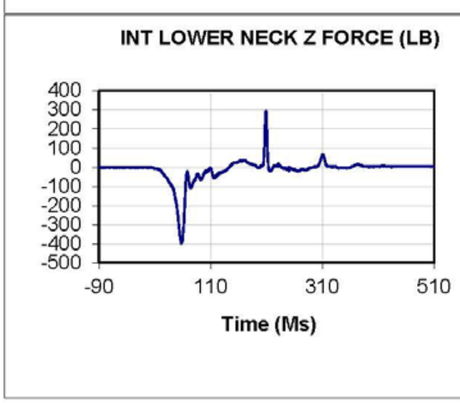
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



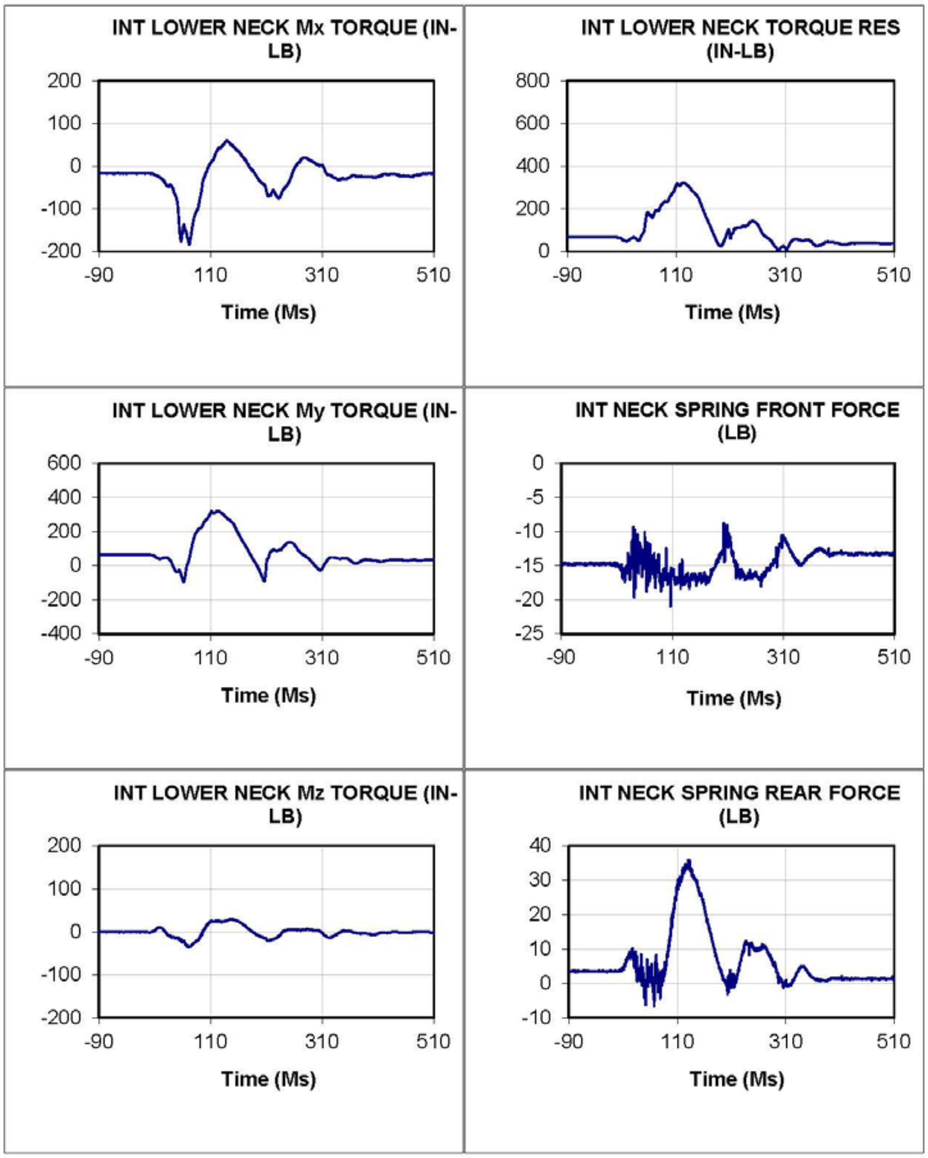








201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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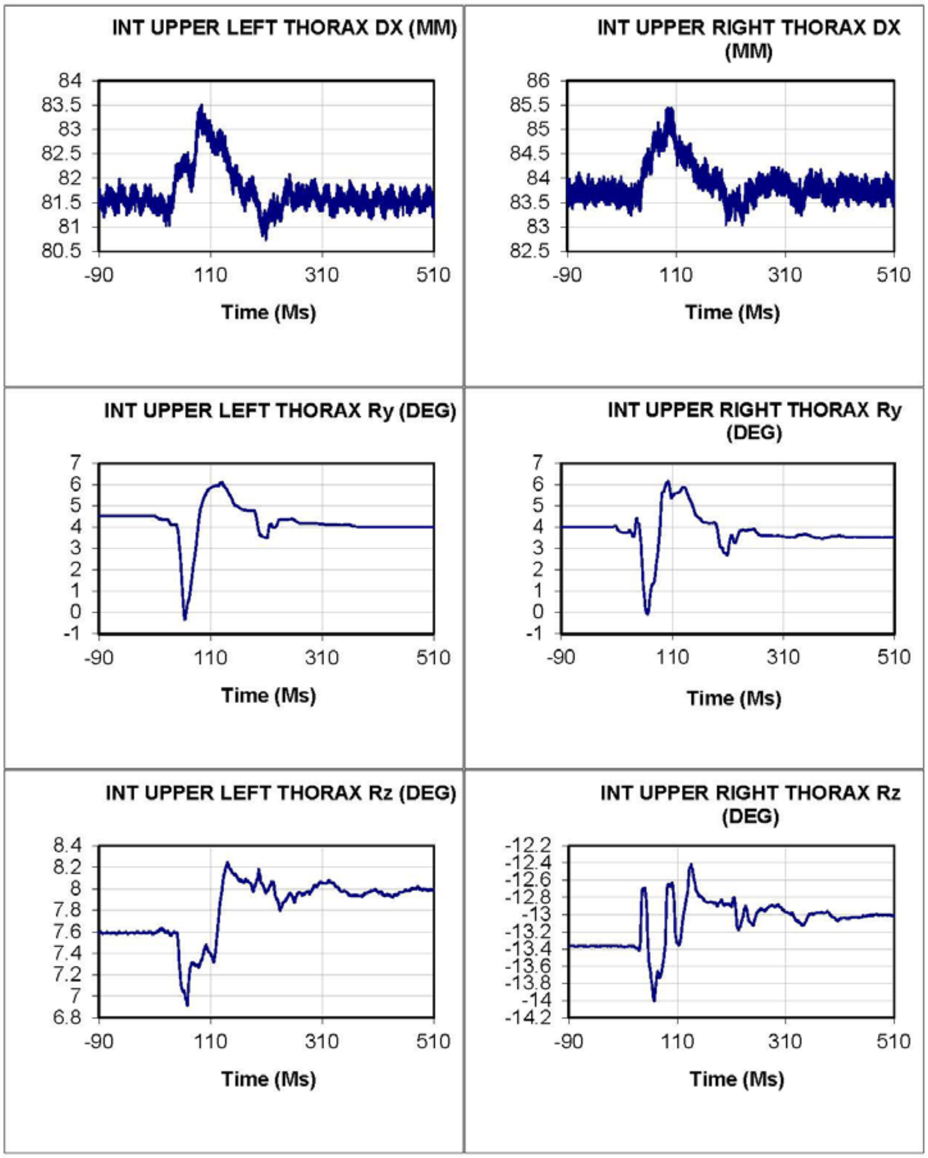
Distribution A: Approved for public release; distribution unlimited.
88 ABW/PA Cleared 02/12/2014; 88ABW-2014-0506.

201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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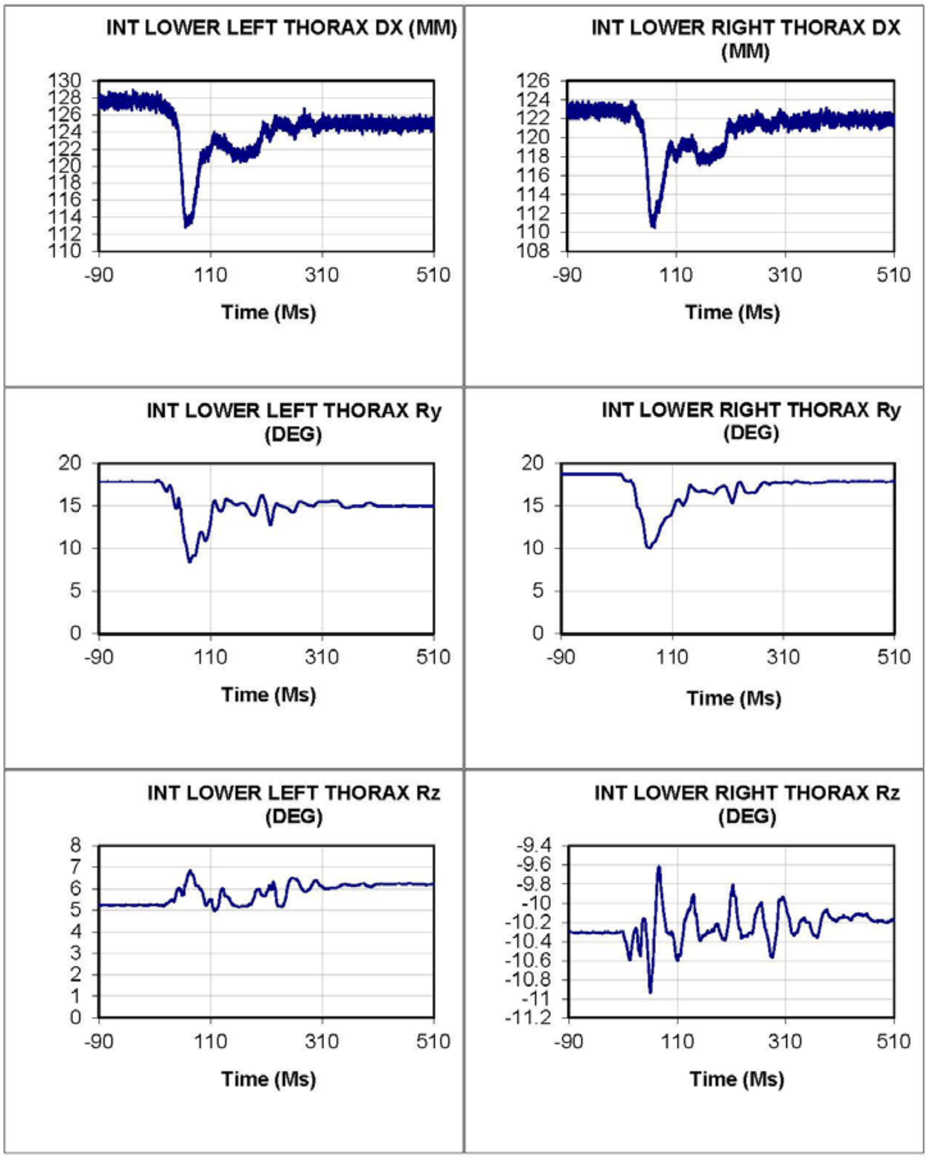
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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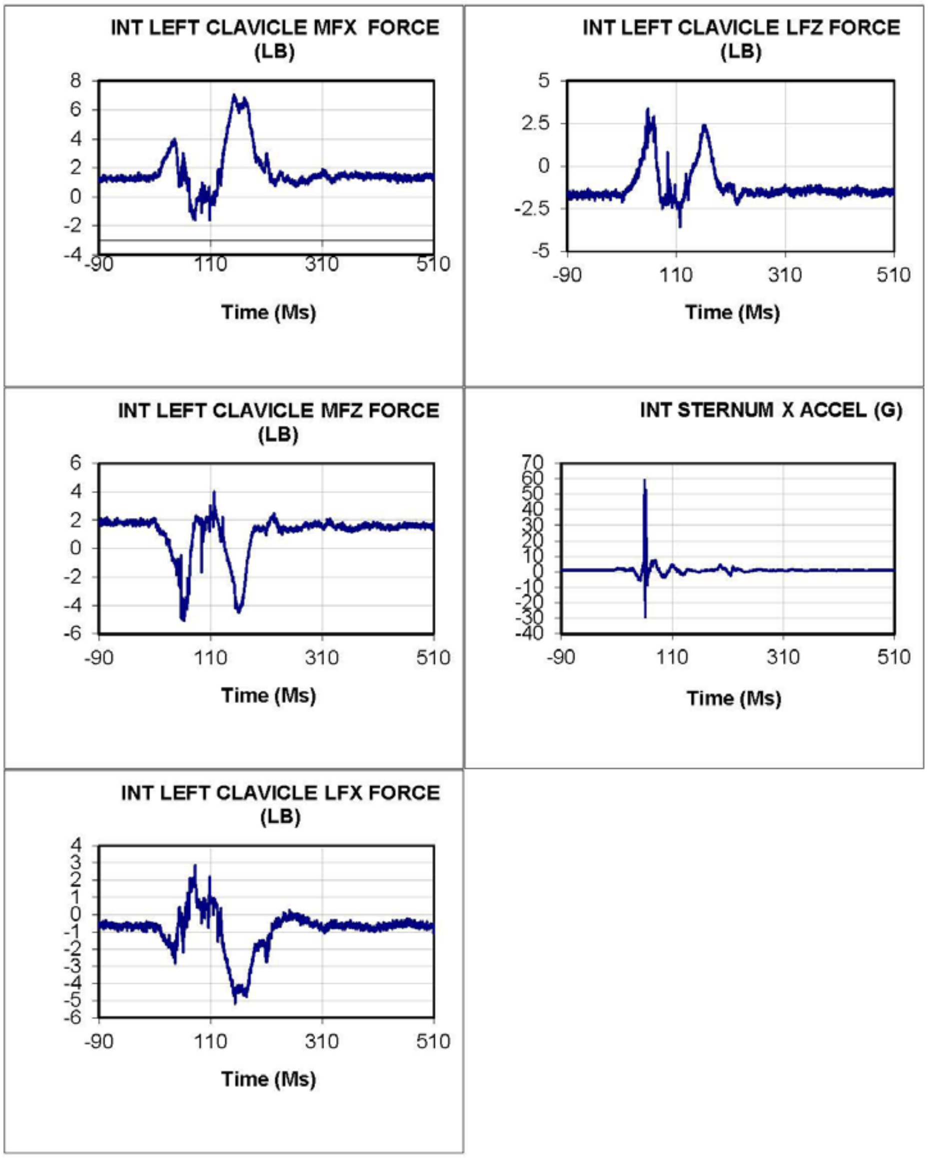
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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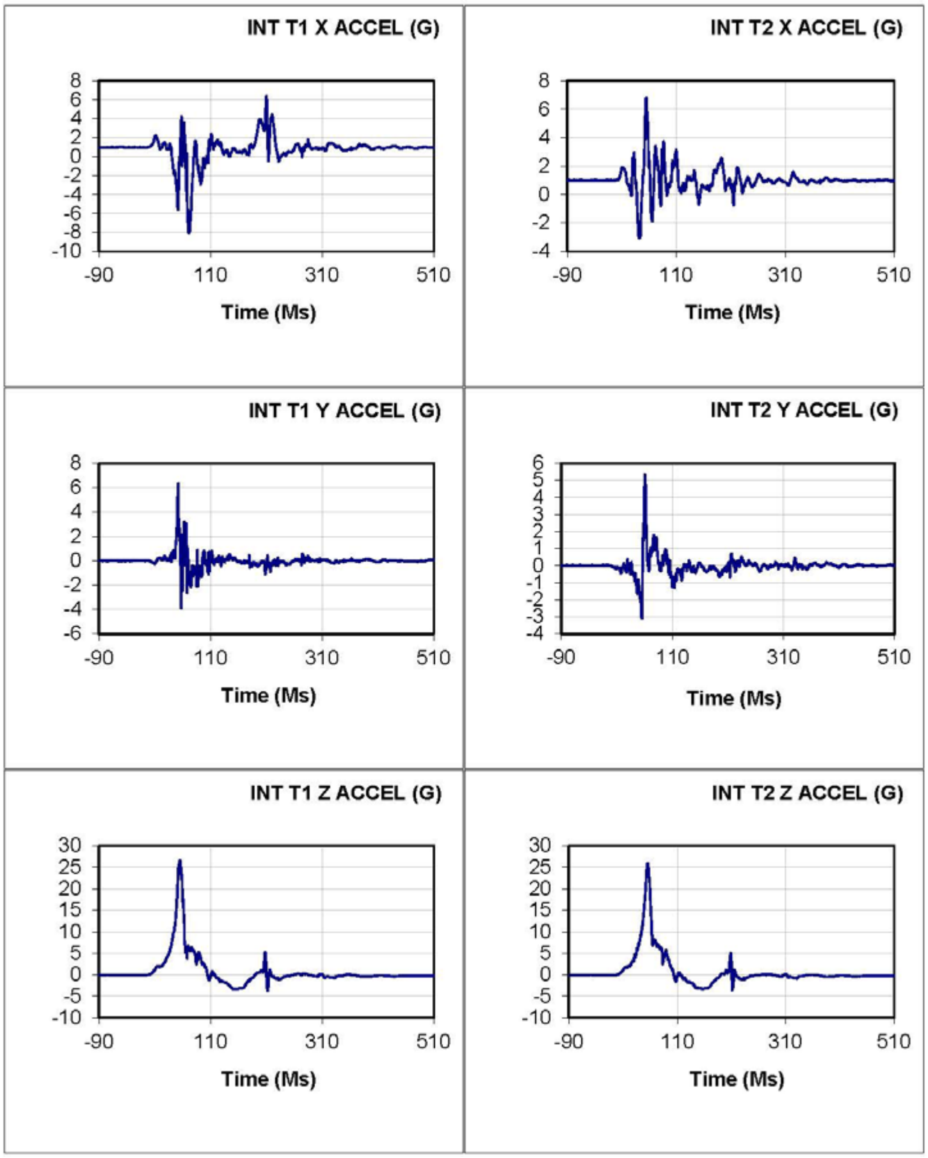
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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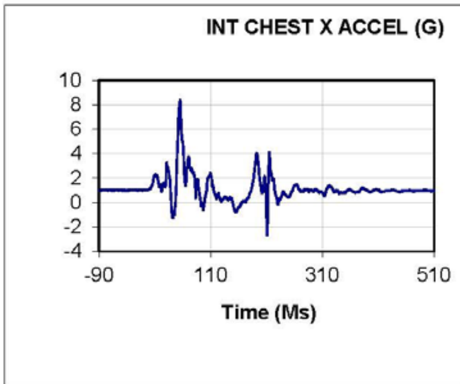
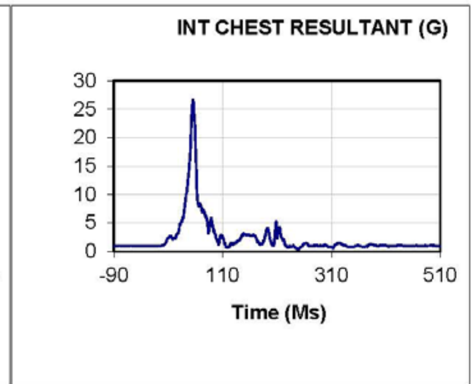
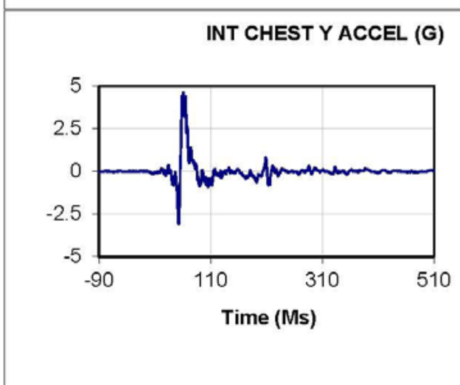
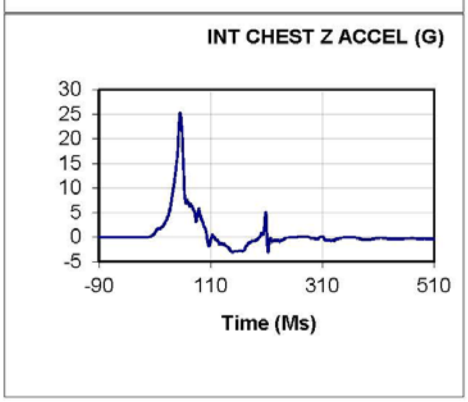
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1









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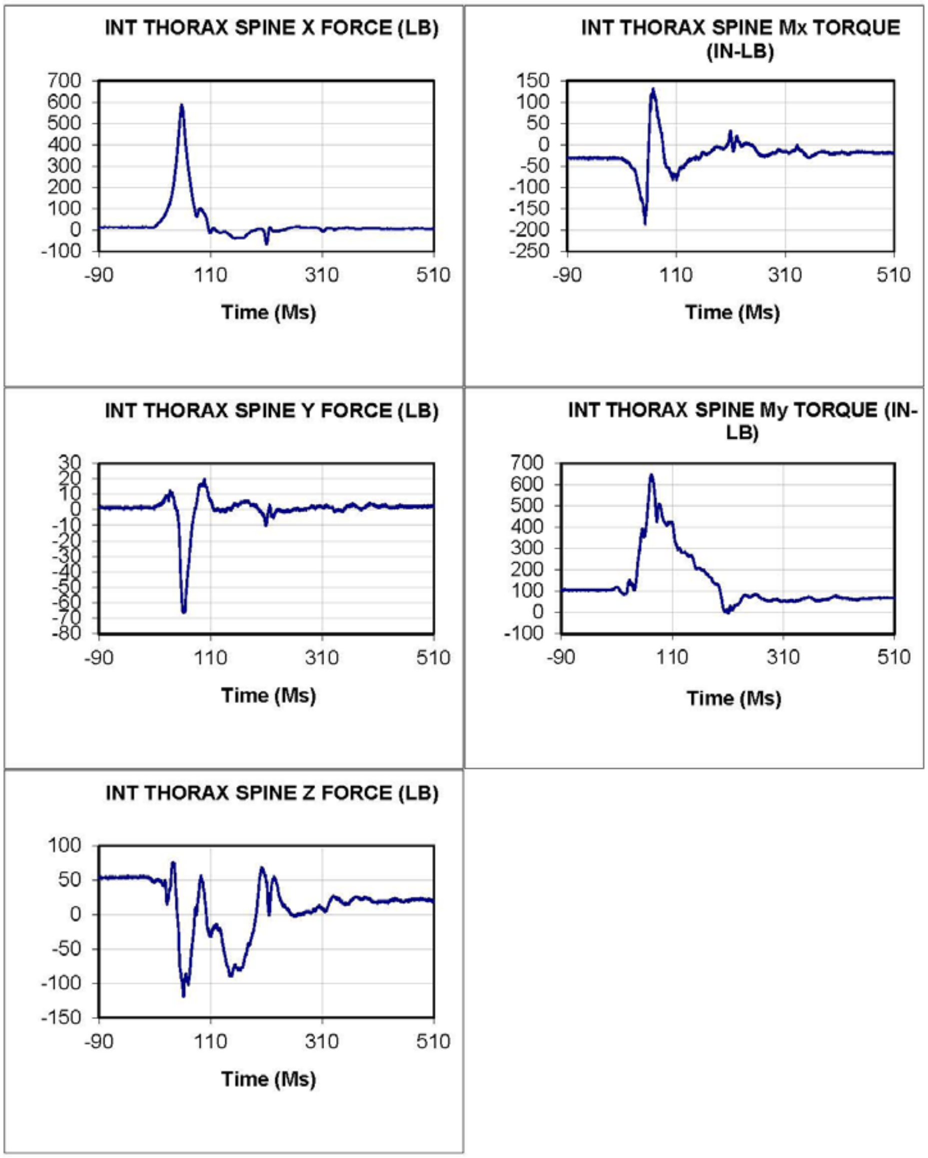
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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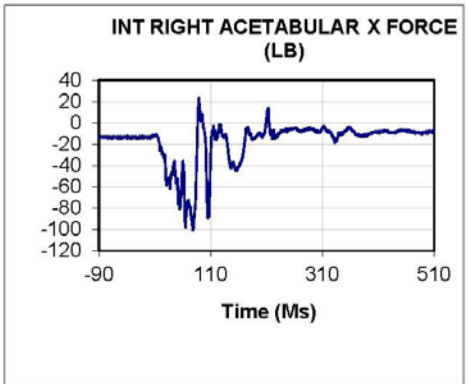
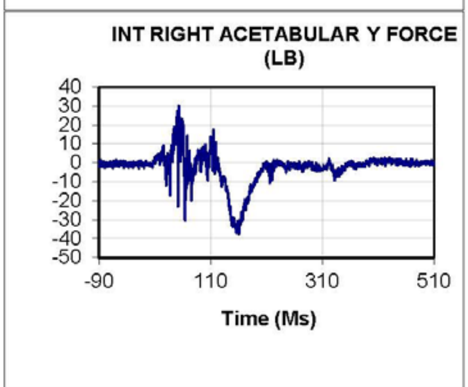
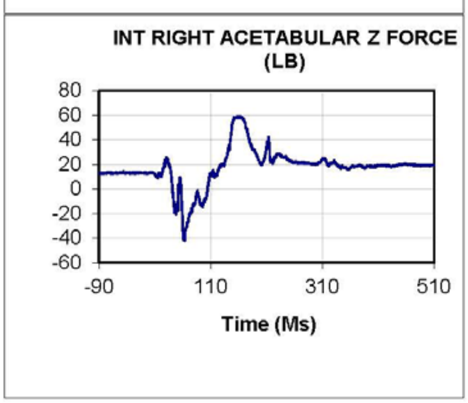
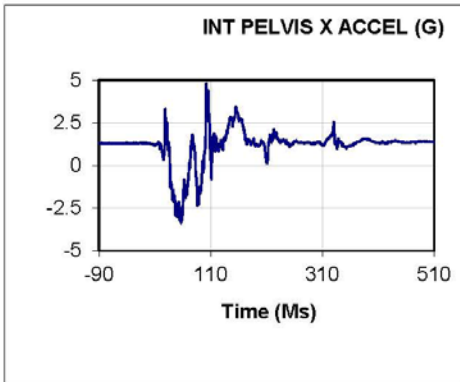
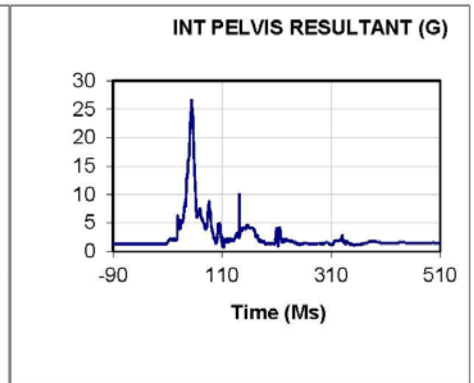

INT RIGHT ACETABULAR X FORCE
(LB)
40
20
0
-20
-40
-60
-80
-100
-120
-90
110
310
510
Time (Ms)

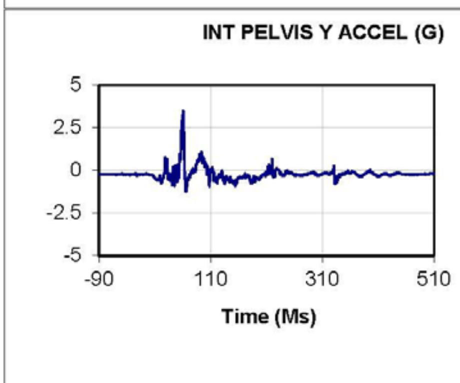

INT RIGHT ACETABULAR Y FORCE
(LB)
40
30
20
10
0
-10
-20
-30
-40
-50
-90
110
310
510
Time (Ms)

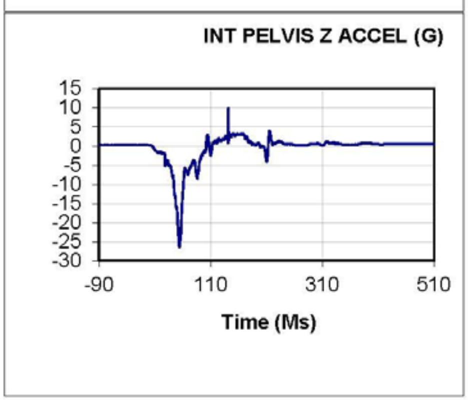

INT RIGHT ACETABULAR Z FORCE
(LB)
80
60
40
20
0
-20
-40
-60
-90
110
310
510
Time (Ms)

201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1









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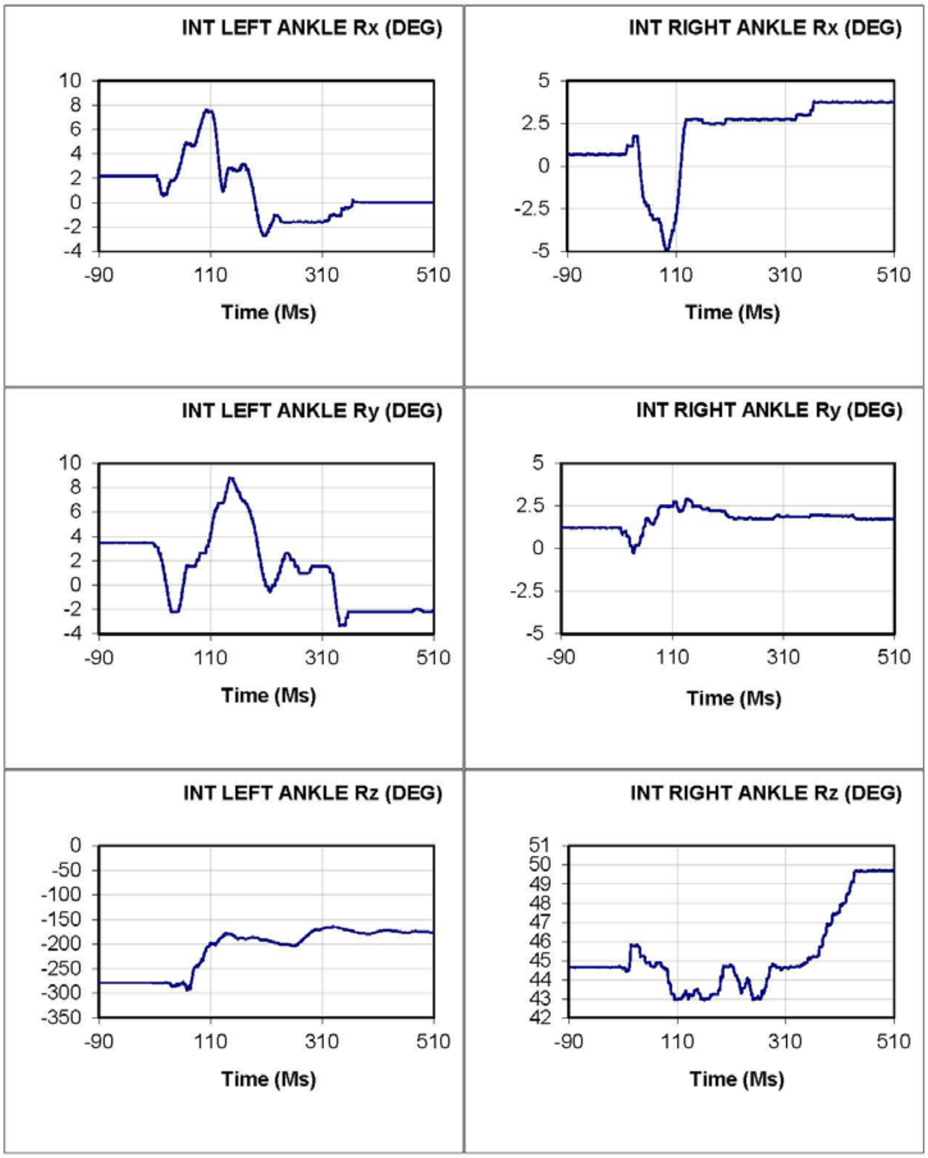
201302 Test: 8658 Test Date: 130122 Subj: THOR Cell: A1



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201302 Test: 8667 Test Date: 130124 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: E3

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
Reference Mark Time (Ms)				12.5	
Impact Rise Time (Ms)				62.7	
Impact Duration (Ms)				172.7	
Velocity Change (Ft/Sec)		36.41			
SLED X ACCEL (G)	0.01	10.08	-0.62	62.7	286.8
SLED VELOCITY (FT/SEC)	-0.07	34.31	-0.04	175.5	0.0
INTEGRATED ACCEL (FT/SEC)	0.02	36.41	0.05	172.7	0.0
LEFT HEADREST X FORCE (LB)	4.56	740.96	-81.77	279.7	291.2
RIGHT HEADREST X FORCE (LB)	7.35	649.14	-99.74	279.9	291.2
CT HEADREST X FORCE (LB)	-8.61	25.55	-138.61	69.5	279.5
HEADREST X SUM (LB)	3.30	1253.67	-161.99	279.8	291.1
LF UPPER BACK X FORCE (LB)	23.34	163.20	-20.61	69.8	213.5
RT UPPER BACK X FORCE (LB)	34.90	185.86	-15.04	69.7	280.9
CT UPPER BACK X FORCE (LB)	19.99	135.28	-50.31	293.9	72.2
UPPER BACKPLATE X SUM (LB)	78.23	339.69	-42.42	290.2	110.0
LF LOWER BACK X FORCE (LB)	32.71	229.51	-39.04	189.5	281.9
RT LOWER BACK X FORCE (LB)	30.16	306.86	-31.83	68.9	281.9
CT LOWER BACK X FORCE (LB)	5.72	381.77	-42.17	69.6	294.1
LOWER BACKPLATE X SUM (LB)	68.59	832.95	-58.78	69.0	282.1
LEFT SEAT PAN Z FORCE (LB)	11.74	476.47	-70.29	73.0	290.5
RIGHT SEAT PAN Z FORCE (LB)	7.34	571.18	-80.74	68.5	288.6
CENTER SEAT PAN Z FORCE (LB)	37.52	1844.41	-52.86	67.8	289.8
SEAT PAN Z SUM (LB)	56.60	2880.58	-170.61	68.0	289.5
SEAT PAN Z MINUS TARE (LB)	56.83	3128.90	-180.19	68.0	289.5
LEFT SHOULDER X FORCE (LB)	-9.75	12.17	-34.45	281.8	279.6
LEFT SHOULDER Y FORCE (LB)	2.65	25.45	-16.81	281.9	284.0
LEFT SHOULDER Z FORCE (LB)	6.53	27.88	-6.54	70.2	291.4
LEFT SHOULDER RES (LB)	12.04	35.36	2.27	279.6	291.8
RIGHT SHOULDER X FORCE (LB)	-10.33	16.98	-35.75	282.2	77.3
RIGHT SHOULDER Y FORCE (LB)	-3.77	17.33	-26.54	283.6	281.8
RIGHT SHOULDER Z FORCE (LB)	1.23	30.23	-8.23	78.3	293.8
RIGHT SHOULDER RES (LB)	11.08	46.92	1.30	78.3	296.0
LEFT LAP X FORCE (LB)	-13.60	14.68	-61.06	62.5	261.3
LEFT LAP Y FORCE (LB)	-0.85	10.16	-16.38	204.9	62.6
LEFT LAP Z FORCE (LB)	-6.35	12.53	-34.40	63.4	261.2

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201302 Test: 8667 Test Date: 130124 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: E3

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
LEFT LAP RESULTANT (LB)	15.04	70.46	2.19	261.2	156.8
RIGHT LAP X FORCE (LB)	-12.50	15.13	-56.65	61.3	261.1
RIGHT LAP Y FORCE (LB)	2.17	10.19	-3.24	99.4	268.1
RIGHT LAP Z FORCE (LB)	-9.57	3.06	-41.30	62.2	260.5
RIGHT LAP RESULTANT (LB)	15.91	66.51	3.56	262.2	11.9
CROTCH STRAP X FORCE (LB)	4.28	20.29	-10.91	259.3	52.2
CROTCH STRAP Y FORCE (LB)	-2.71	0.86	-6.38	56.4	53.6
CROTCH STRAP Z FORCE (LB)	-19.06	11.63	-63.96	70.9	251.1
CROTCH STRAP FORCE (LB)	19.74	66.61	1.48	251.2	33.9
RIGHT HEADREST Y FORCE (LB)	-20.46	607.01	-33.49	260.9	215.9
RT SHOULDER PLATE Y (LB)	21.04	34.19	-6799.92	9.0	260.9
RIGHT PELVIS PLATE Y FORCE (LB	-7.80	6.10	-6847.54	124.7	260.9
INT HEAD X ACCEL (G)	1.02	100.10	-6.47	279.0	298.4
INT HEAD Y ACCEL (G)	0.00	2.63	-7.10	298.8	280.0
INT HEAD Z ACCEL (G)	-0.01	25.35	-21.85	72.0	281.4
INT HEAD RESULTANT (G)	1.02	100.23	0.12	279.0	427.6
INT HEAD HIC		188.59		277.5	281.4
INT HEAD Rx ANG (RAD/SEC2)	-2.00	137.34	-96.63	76.8	156.3
INT HEAD Ry ANG (RAD/SEC2)	-2.18	649.28	-690.90	114.9	243.6
INT HEAD Rz ANG (RAD/SEC2)	3.22	91.20	-197.76	473.7	281.0
INT NECK X FORCE (LB)	-8.91	15.47	-105.01	275.6	162.2
INT NECK Y FORCE (LB)	1.46	6.61	-12.22	279.6	74.7
INT NECK Z FORCE (LB)	1.26	317.19	-305.51	280.4	71.8
INT NECK RESULTANT (LB)	9.15	319.35	0.97	280.4	378.8
INT NECK Mx TORQUE (IN-LB)	-2.13	30.56	-50.70	73.9	81.6
INT NECK My TORQUE (IN-LB)	3.82	101.21	-34.29	165.8	275.3
INT NECK Mz TORQUE (IN-LB)	-6.05	10.18	-12.89	119.1	159.8
INT NECK TORQUE RES (IN-LB)	7.50	101.76	2.06	165.8	51.7
INT LOWER NECK X FORCE (LB)	-0.16	53.63	-41.20	72.4	195.5
INT LOWER NECK Y FORCE (LB)	-1.98	8.68	-20.95	281.8	72.7
INT LOWER NECK Z FORCE (LB)	-1.93	337.43	-392.22	280.9	71.3
INT LOWER NECK RES (LB)	2.92	395.97	2.13	71.8	1.5
INT LOWER NECK Mx (IN-LB)	2.87	37.72	-75.61	280.8	75.1
INT LOWER NECK My (IN-LB)	31.41	430.41	-129.73	170.3	279.0
INT LOWER NECK Mz (IN-LB)	-2.28	15.77	-17.84	479.9	85.7

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201302 Test: 8667 Test Date: 130124 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: E3

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT LOWER NECK RES (IN-LB)	31.63	430.45	6.02	170.3	41.0
INT NECK SPRING FRONT FORCE (	-9.78	5.39	-16.56	278.7	76.7
INT NECK SPRING REAR FORCE (L	1.98	82.14	-4.38	178.4	282.1
INT OC Ry ANGLE (DEG)	89.39	94.92	85.87	291.5	315.2
INT UPPER LT THORAX DX (MM)	81.31	83.79	80.10	170.0	295.7
INT UPPER LT THORAX RY (DEG)	3.82	5.54	-0.24	231.0	80.6
INT UPPER LT THORAX RZ (DEG)	7.20	8.33	6.96	409.1	75.8
INT UPPER RT THORAX DX (MM)	83.57	85.80	82.51	179.0	297.7
INT UPPER RT THORAX RY (DEG)	3.33	5.79	-0.41	213.8	78.5
INT UPPER RT THORAX RZ (DEG)	-13.69	-12.65	-13.74	404.4	76.9
INT LOWER LT THORAX DX (MM)	126.68	127.85	113.42	11.1	86.4
INT LOWER LT THORAX RY (DEG)	18.77	18.88	7.29	17.4	98.7
INT LOWER LT THORAX RZ (DEG)	5.86	8.28	4.36	91.5	119.1
INT LOWER RT THORAX DX (MM)	123.62	125.59	112.16	309.6	78.6
INT LOWER RT THORAX RY (DEG)	19.15	19.19	10.01	16.9	89.5
INT LOWER RT THORAX RZ (DEG)	-11.08	-10.01	-12.03	402.5	75.7
INT LEFT CLAVICLE MFX (LB)	1.98	5.06	-1.52	117.9	118.5
INT LEFT CLAVICLE MFZ FORCE (L	1.22	2.21	-9.18	293.0	74.6
INT LEFT CLAVICLE LFX FORCE (LB	-1.41	1.18	-3.65	185.0	66.0
INT LEFT CLAVICLE LFZ FORCE (LB	-0.71	5.94	-1.54	75.0	294.3
INT STERNUM X ACCEL (G)	1.01	11.12	-6.10	75.7	287.3
INT T1 X ACCEL (G)	1.03	9.66	-5.55	283.0	87.3
INT T1 Y ACCEL (G)	0.00	7.28	-3.42	69.3	71.1
INT T1 Z ACCEL (G)	-0.02	27.76	-5.41	69.2	283.6
INT T2 X ACCEL (G)	1.02	7.67	-2.42	71.7	299.7
INT T2 Y ACCEL (G)	-0.01	2.20	-4.77	287.0	73.1
INT T2 Z ACCEL (G)	-0.02	23.67	-6.12	68.6	283.7
INT CHEST X ACCEL (G)	1.00	10.40	-5.65	287.4	283.0
INT CHEST Y ACCEL (G)	0.00	3.20	-2.92	77.0	70.0
INT CHEST Z ACCEL (G)	-0.01	22.08	-4.35	69.0	284.4
INT CHEST RESULTANT (G)	1.00	23.02	0.24	69.1	317.3
INT THORAX SPINE X FORCE (LB)	11.44	574.90	-77.34	70.1	282.9
INT THORAX SPINE Y FORCE (LB)	0.14	11.17	-41.73	48.3	75.7
INT THORAX SPINE Z FORCE (LB)	83.17	175.28	-54.10	292.8	125.8
INT THORAX SPINE Mx (IN-LB)	-11.28	19.16	-162.89	309.8	70.9
INT THORAX SPINE My (IN-LB)	154.67	844.84	9.63	72.7	301.1

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201302 Test: 8667 Test Date: 130124 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: E3

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT RIGHT ACETABULAR X (LB)	-2.12	35.99	-124.50	196.6	190.4
INT RIGHT ACETABULAR Y (LB)	-5.98	21.91	-35.10	67.4	257.2
INT RIGHT ACETABULAR Z (LB)	1.82	32.43	-44.31	285.1	138.0
INT PELVIS X ACCEL (G)	1.29	7.10	-4.81	190.0	74.6
INT PELVIS Y ACCEL (G)	-0.27	1.14	-2.41	69.0	75.5
INT PELVIS Z ACCEL (G)	0.41	6.20	-23.49	189.4	66.0
INT PELVIS RESULTANT (G)	1.38	23.53	0.16	66.0	203.9
INT LEFT ANKLE RX (DEG)	1.28	6.36	-1.98	122.7	263.8
INT LEFT ANKLE Ry (DEG)	5.31	8.88	0.46	232.3	47.6
INT LEFT ANKLE Rz (DEG)	54.65	54.69	52.76	163.0	357.2
INT RIGHT ANKLE Rx (DEG)	2.73	3.77	-6.92	447.6	115.1
INT RIGHT ANKLE Ry (DEG)	2.23	3.31	0.20	190.2	451.4
INT RIGHT ANKLE Rz (DEG)	44.10	45.79	43.75	29.1	309.4

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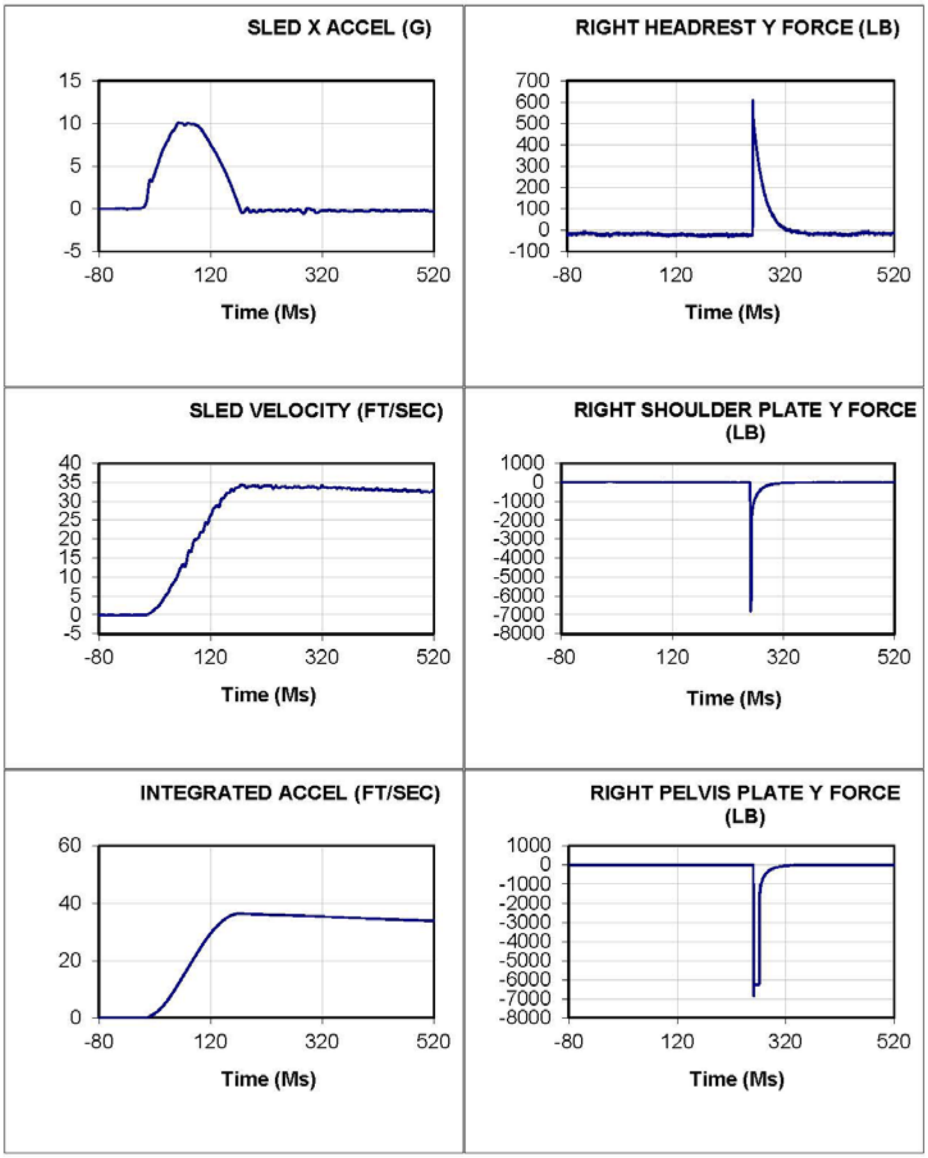

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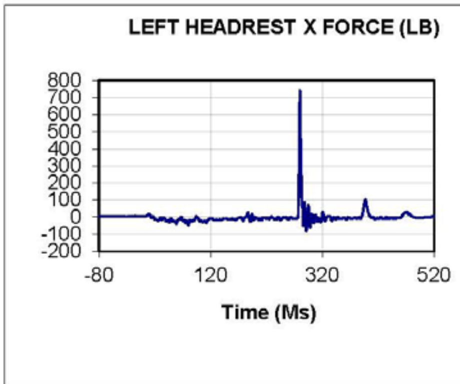

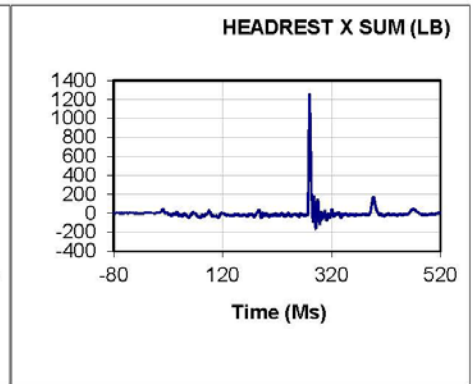

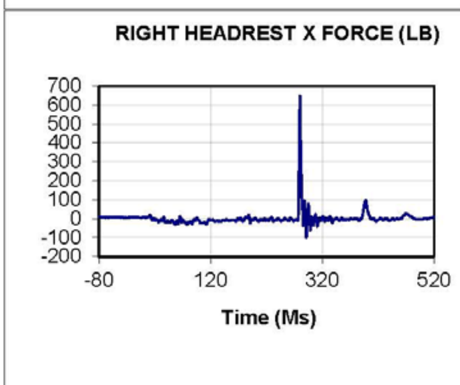

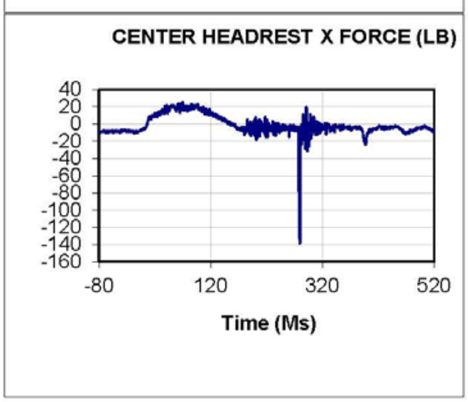

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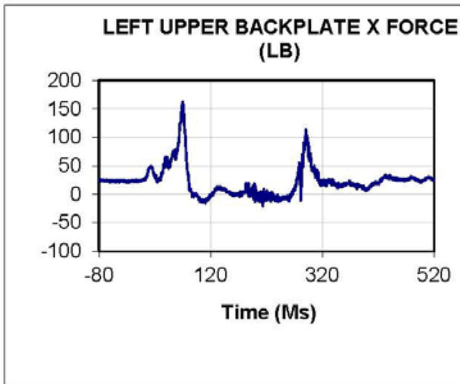

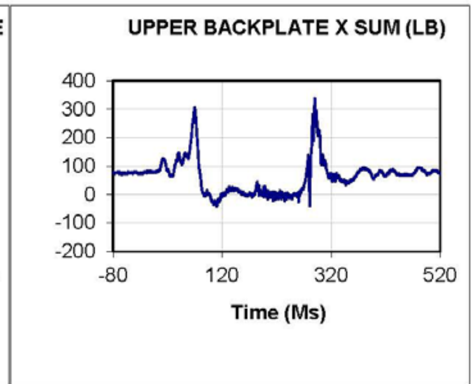

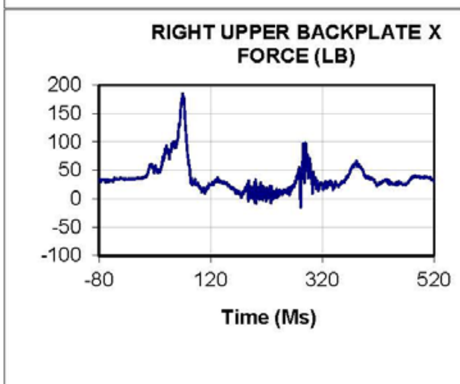

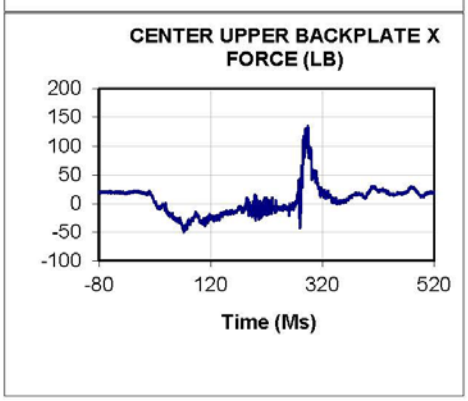

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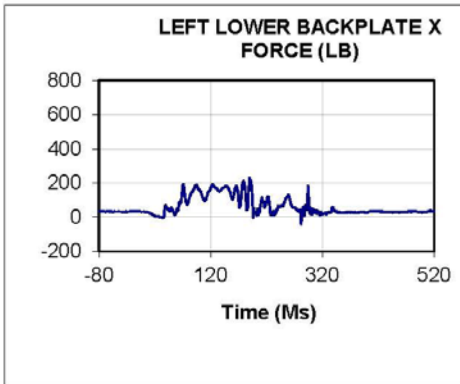

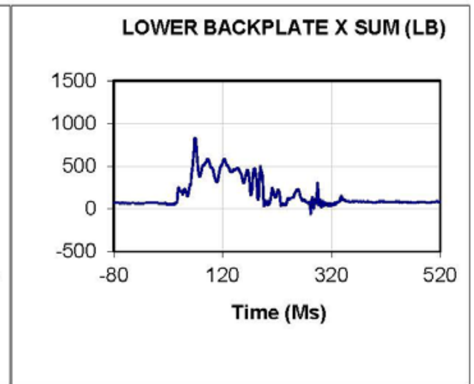

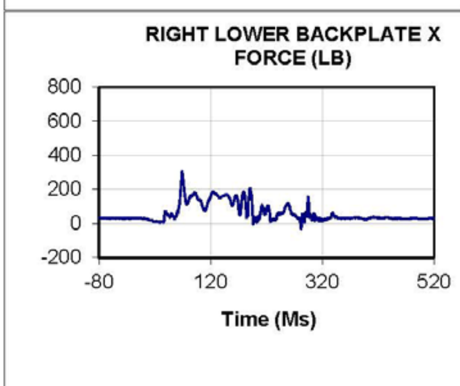

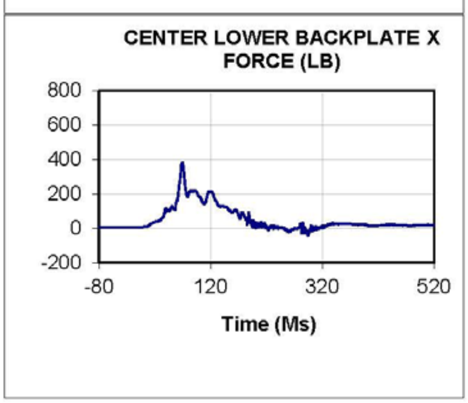

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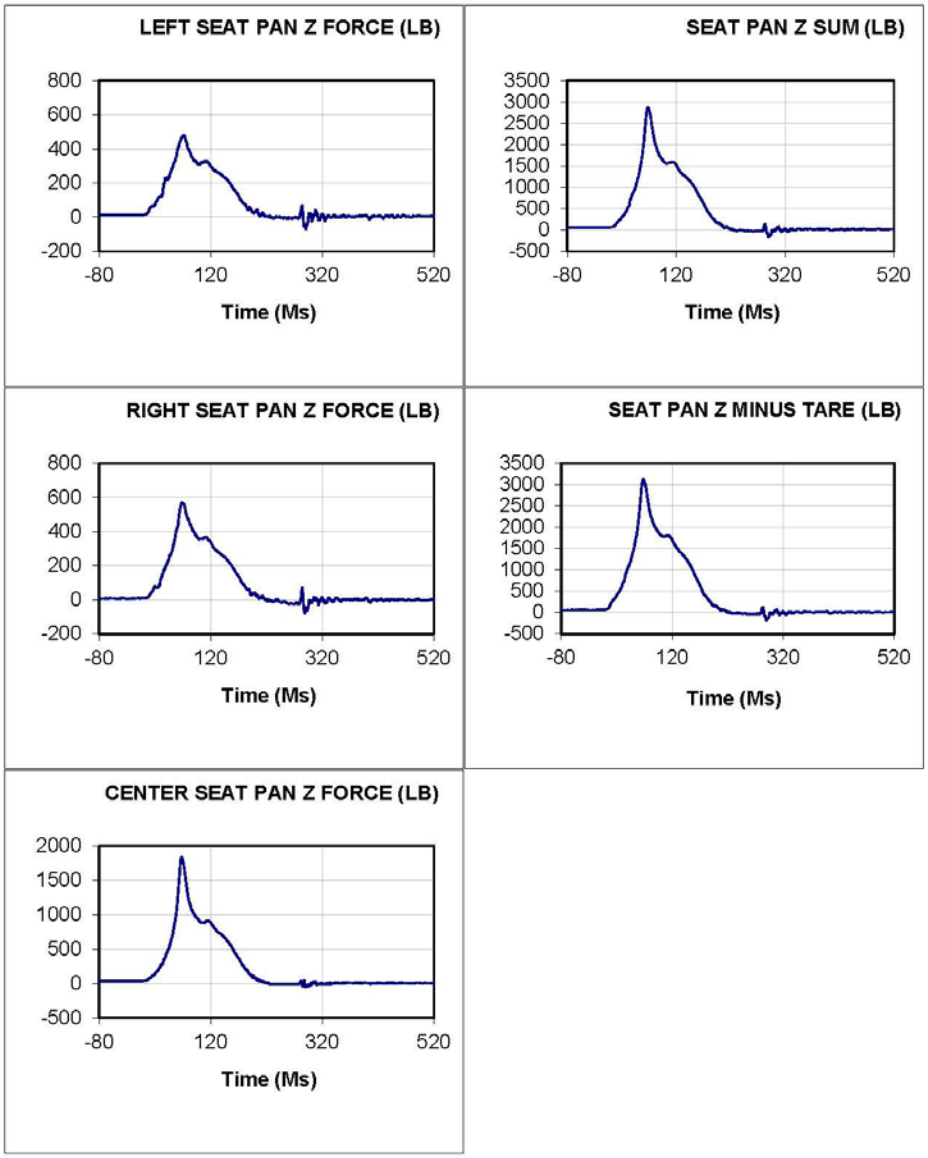

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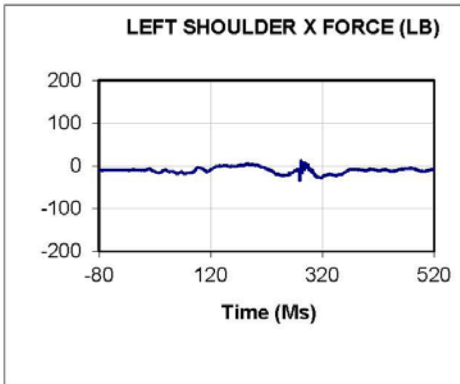

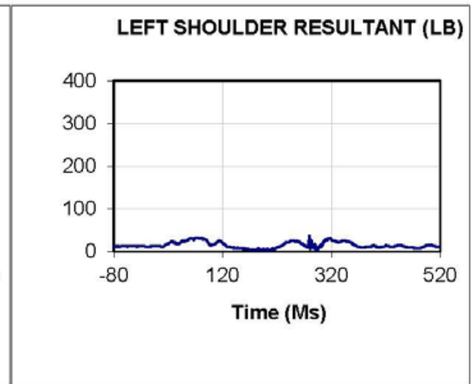

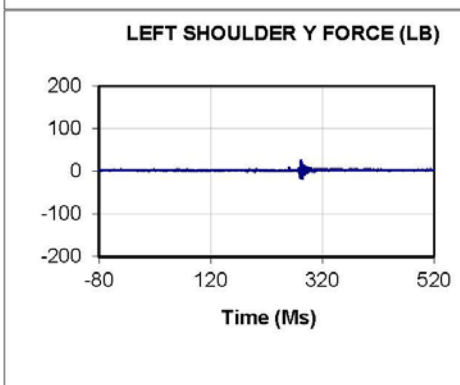

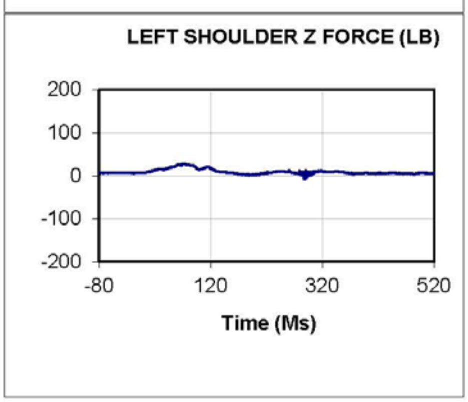

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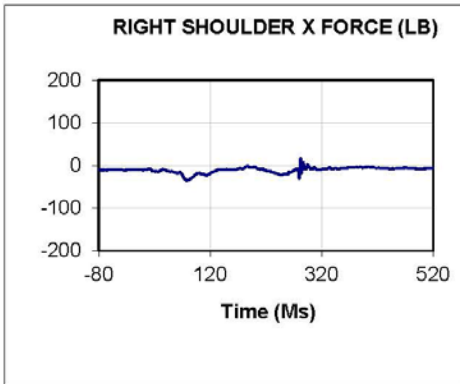

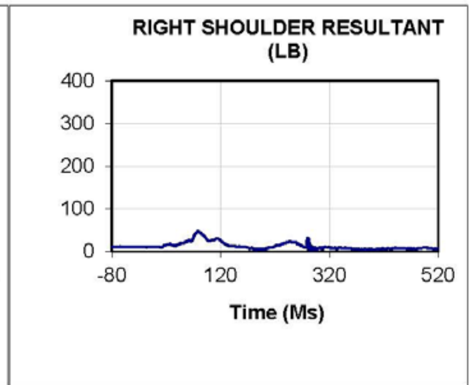

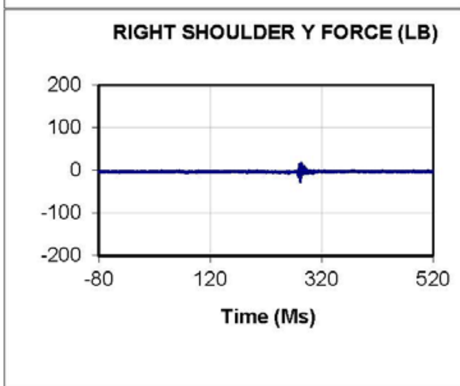

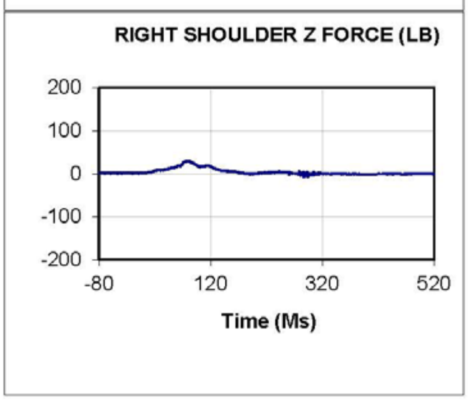

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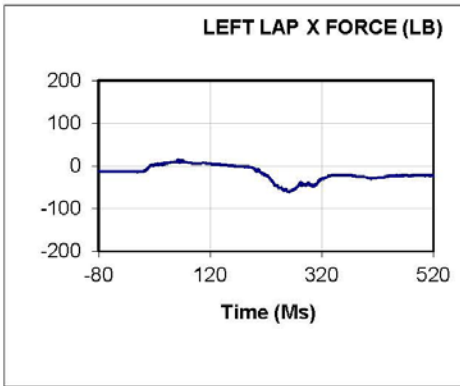

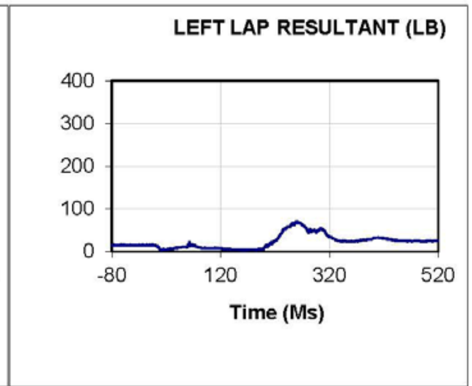

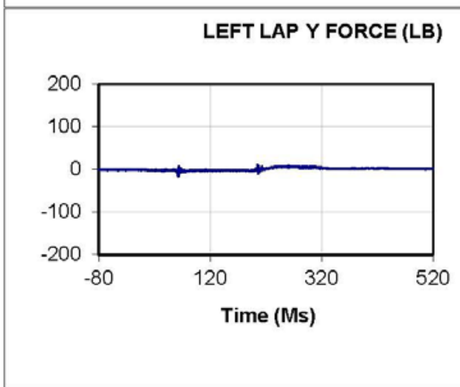

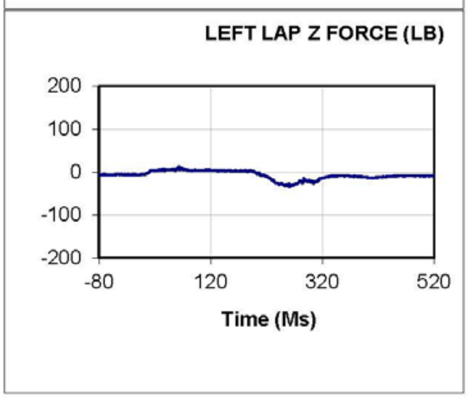

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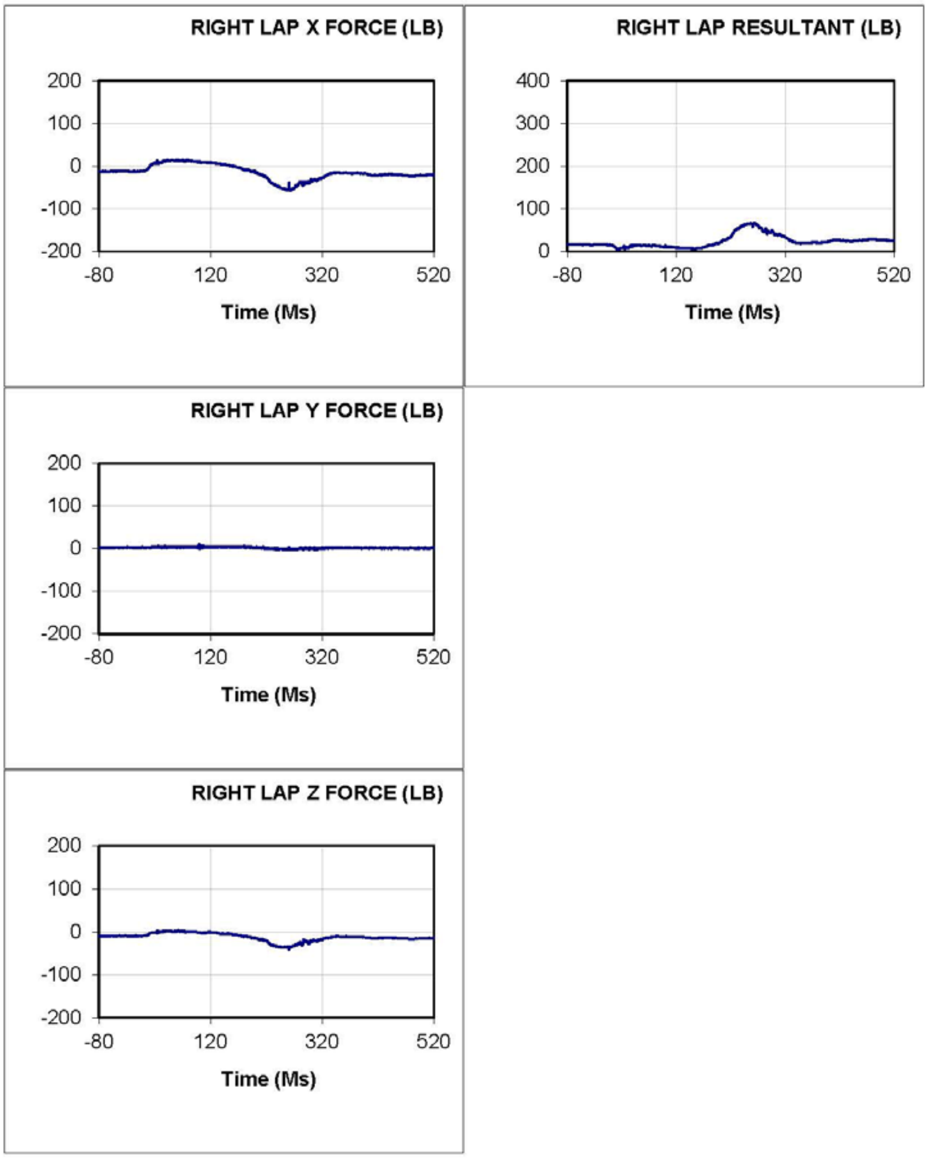

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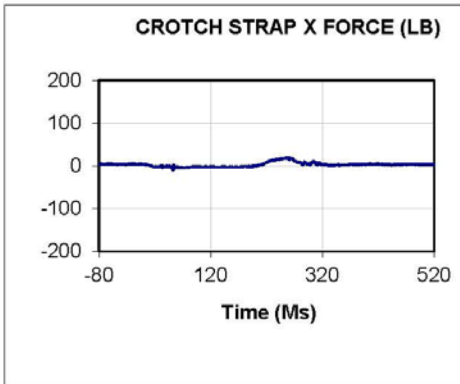

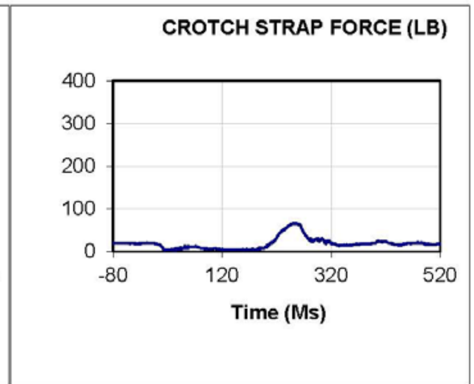

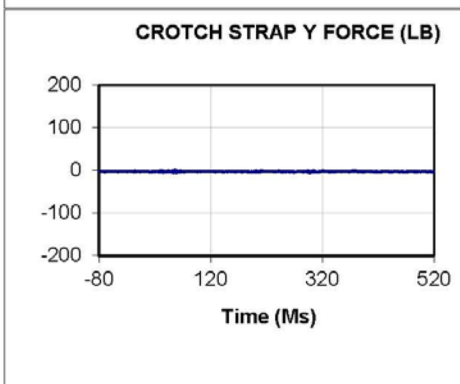

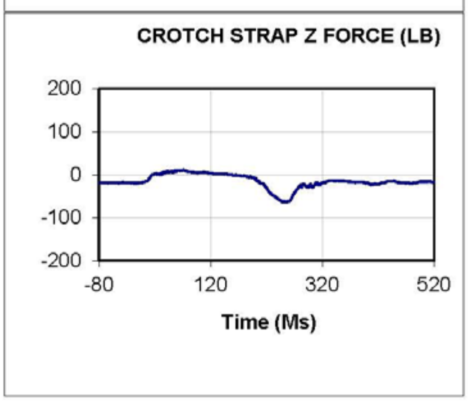

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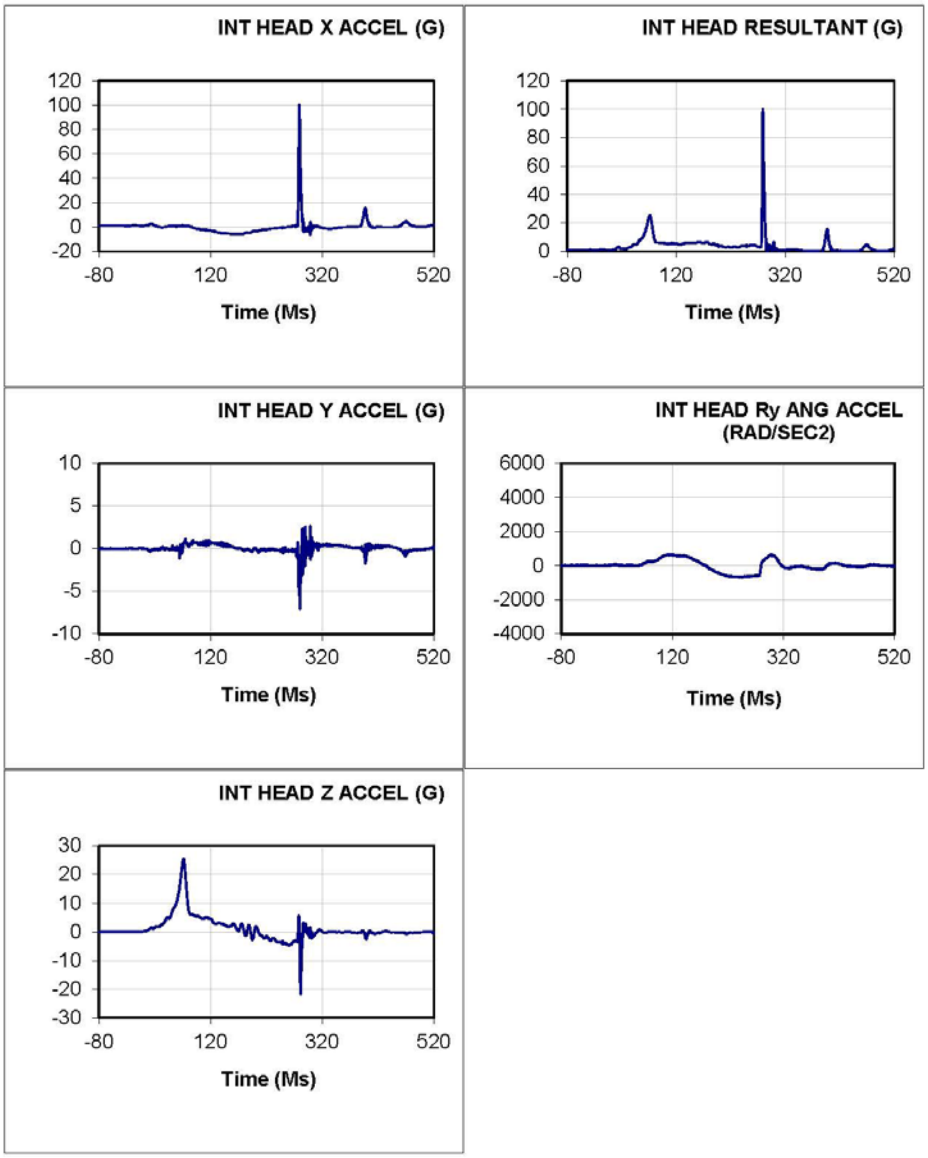

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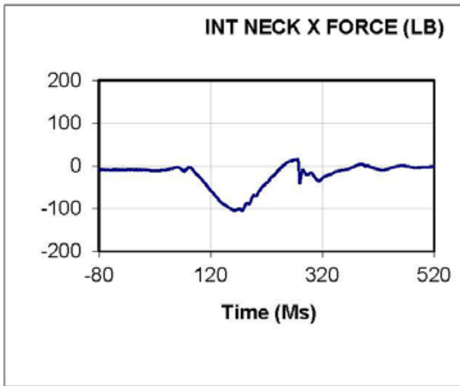

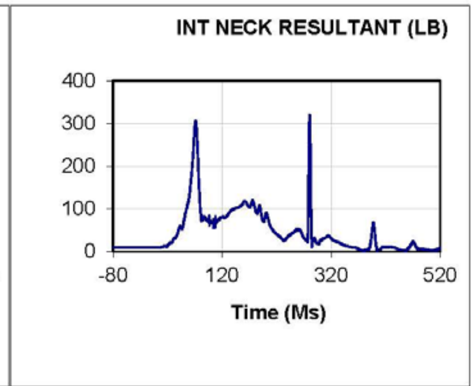

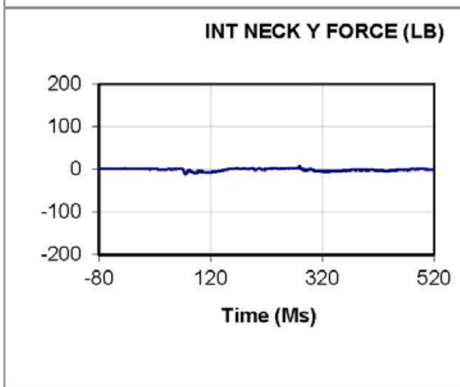

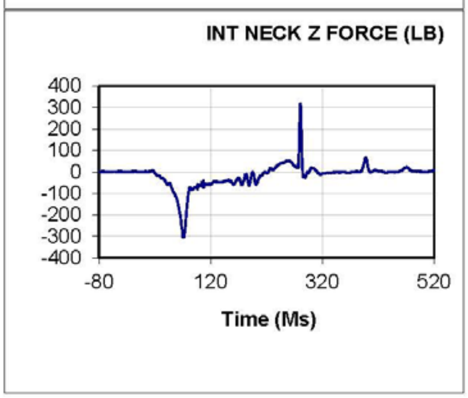

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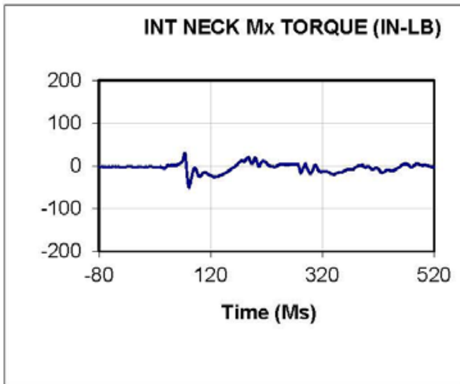

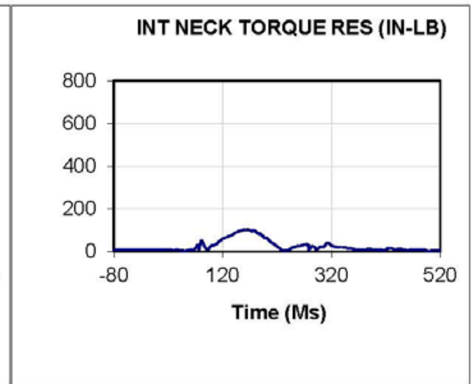

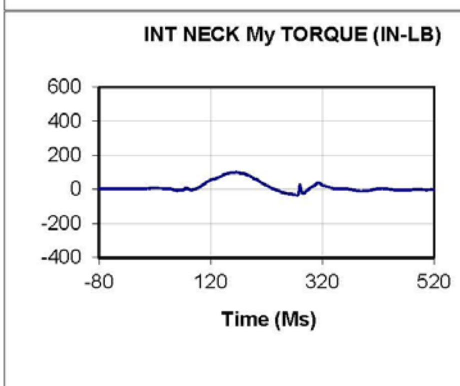

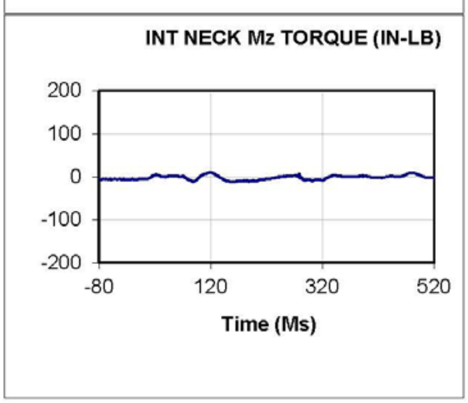

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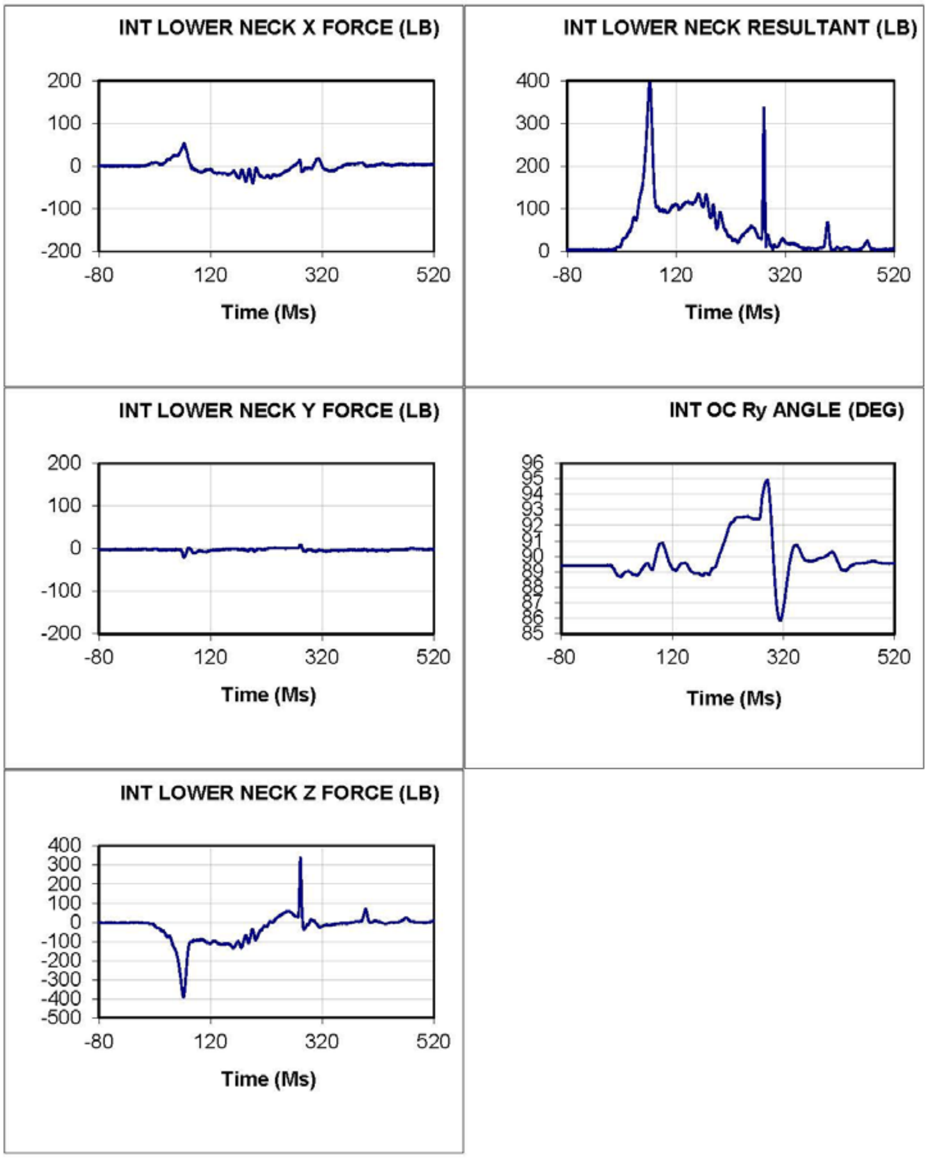

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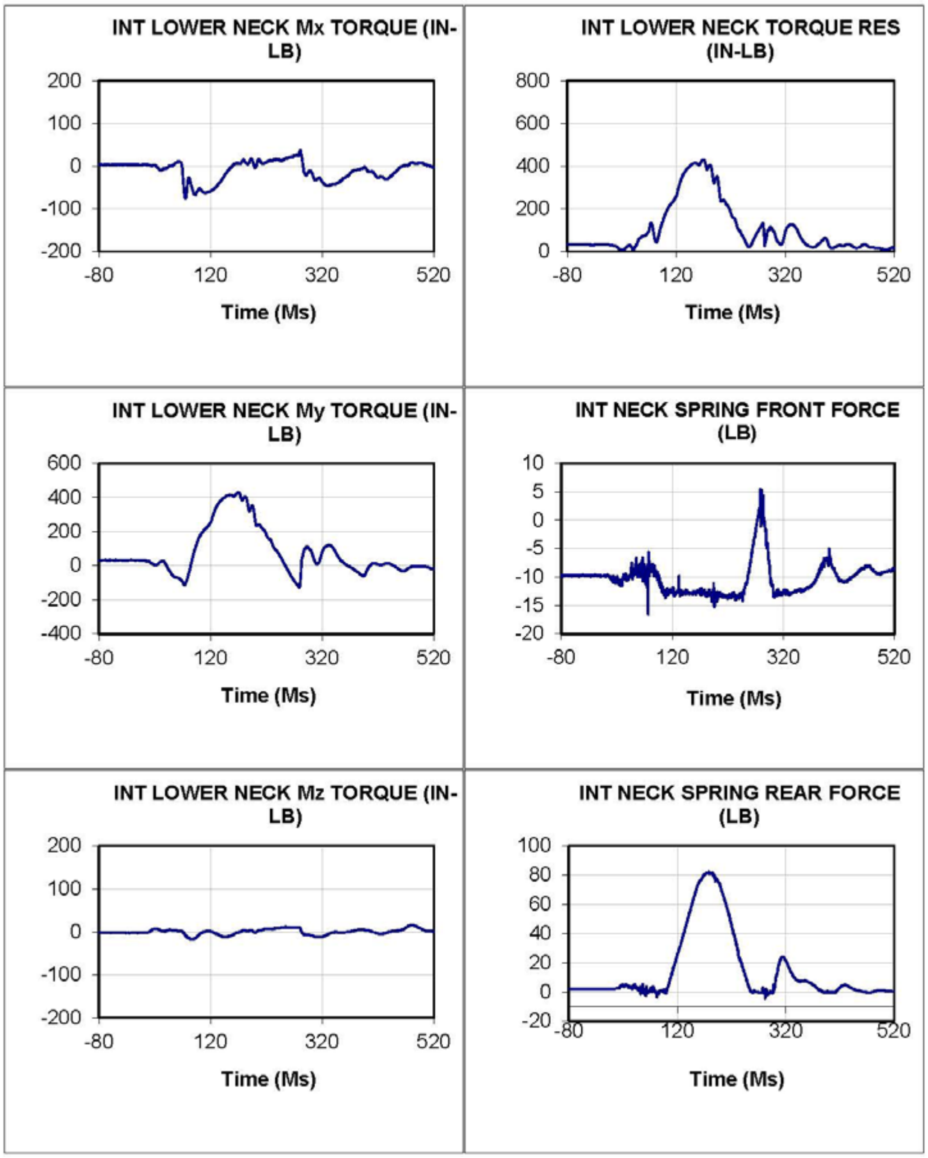

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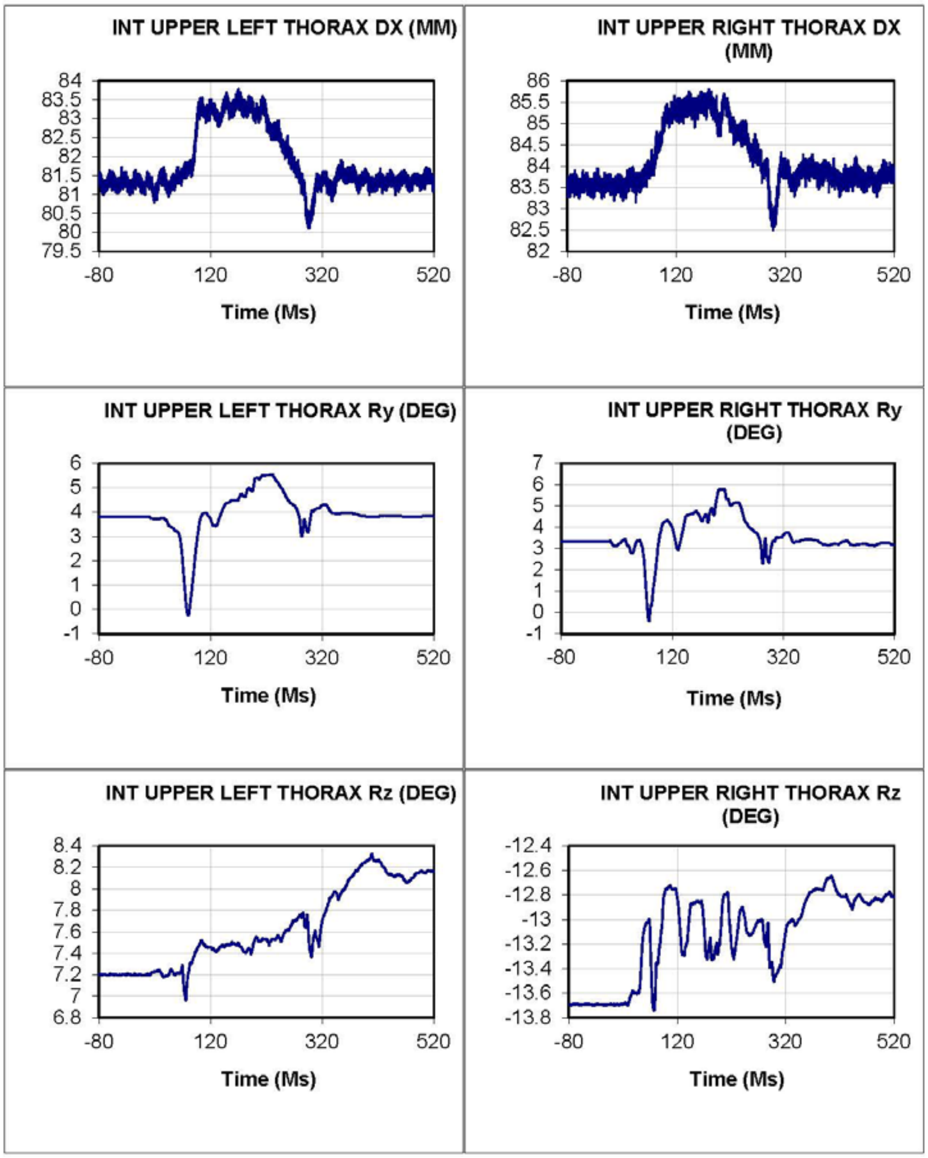

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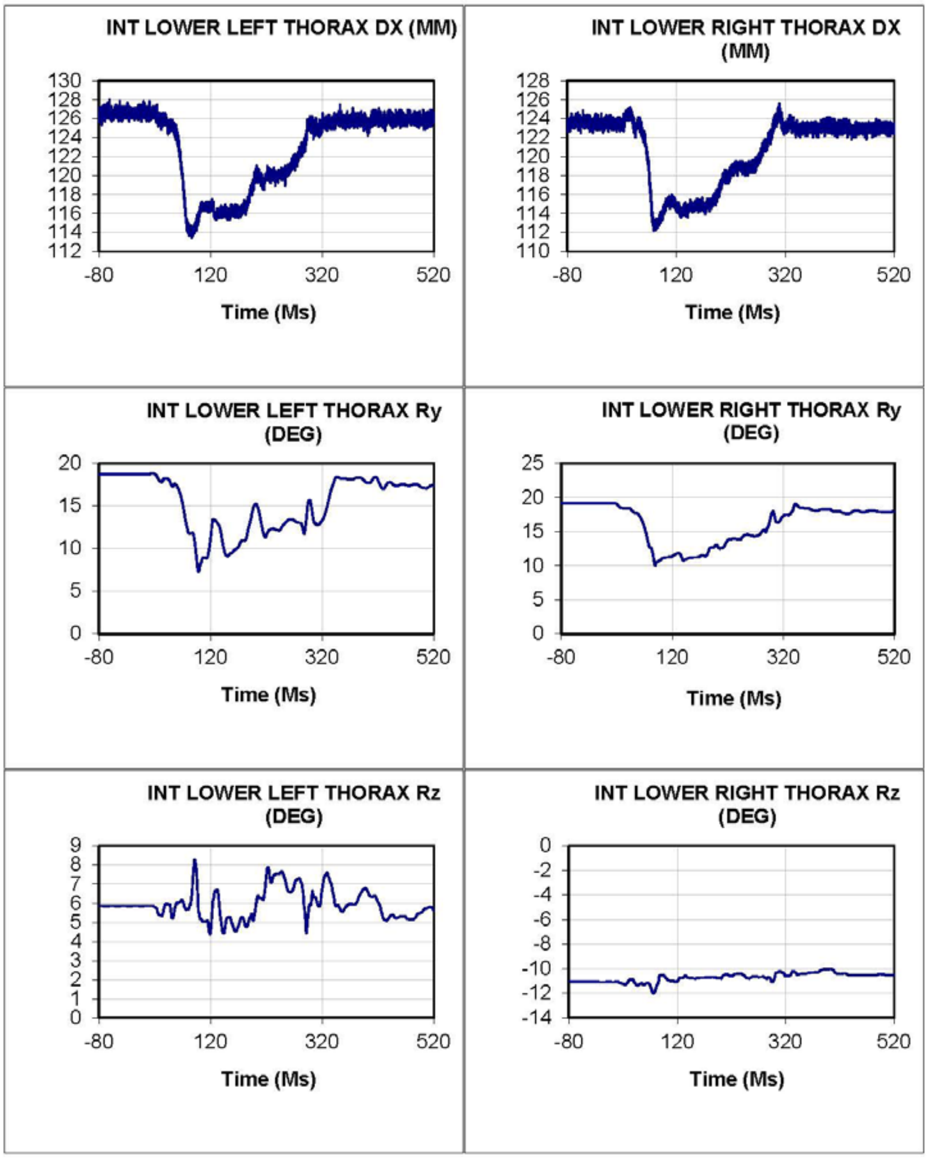

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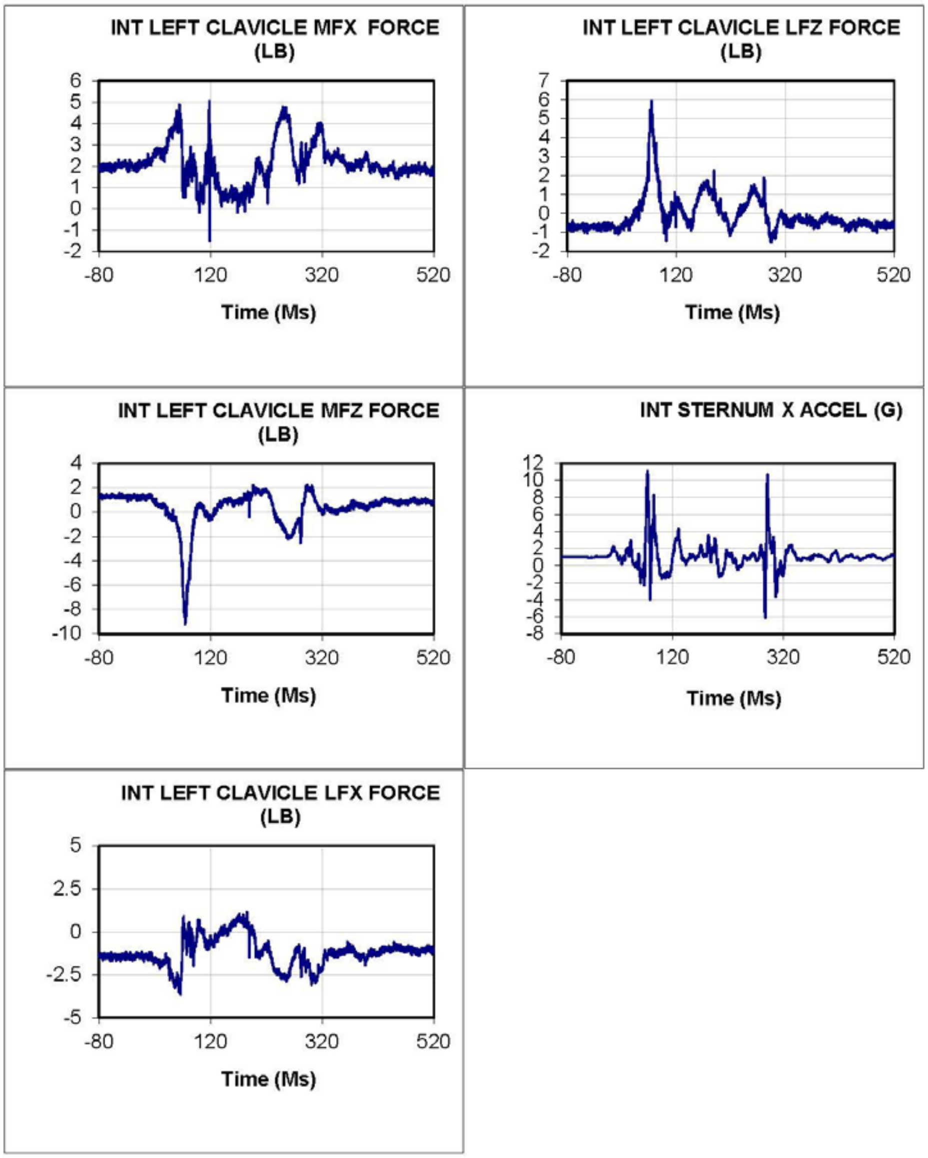

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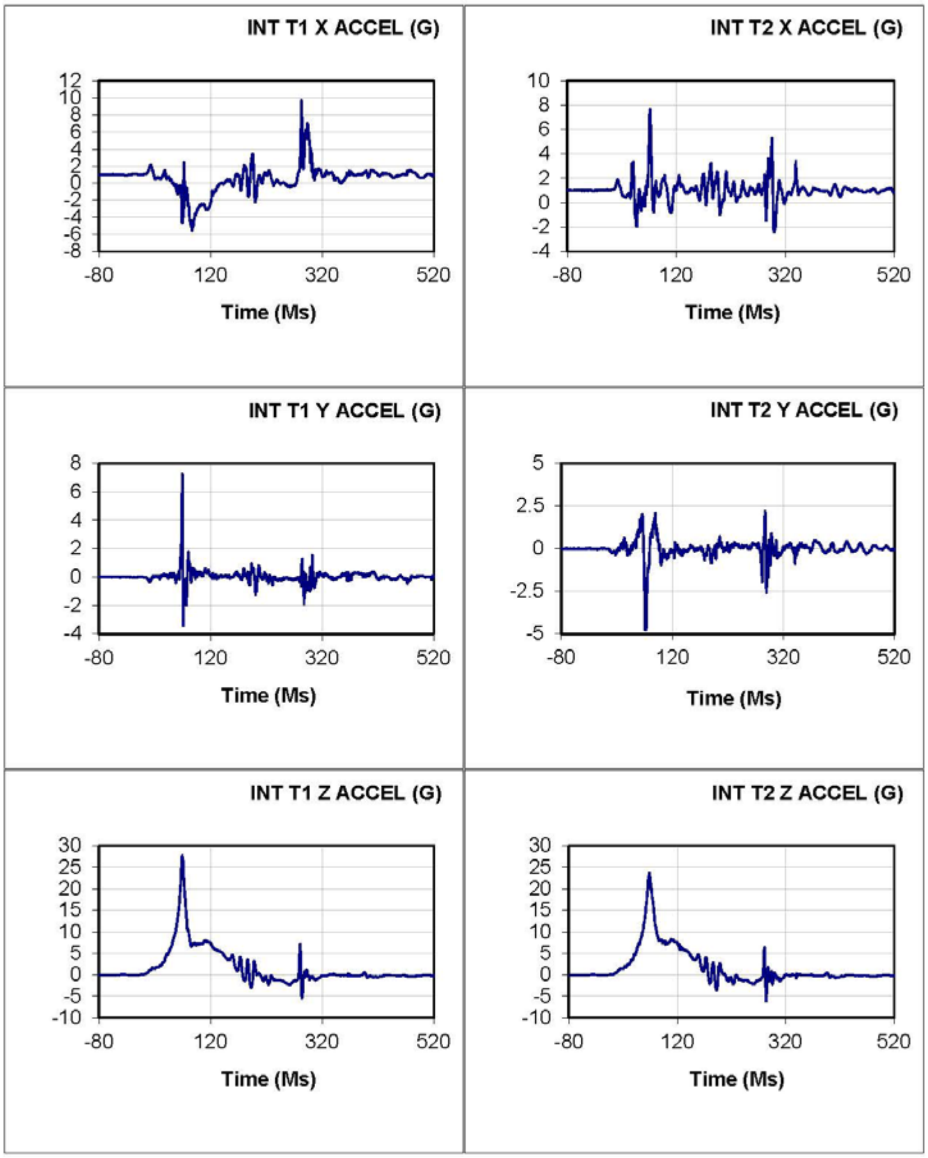
201302 Test: 8667 Test Date: 130124 Subj: THOR Cell: E3



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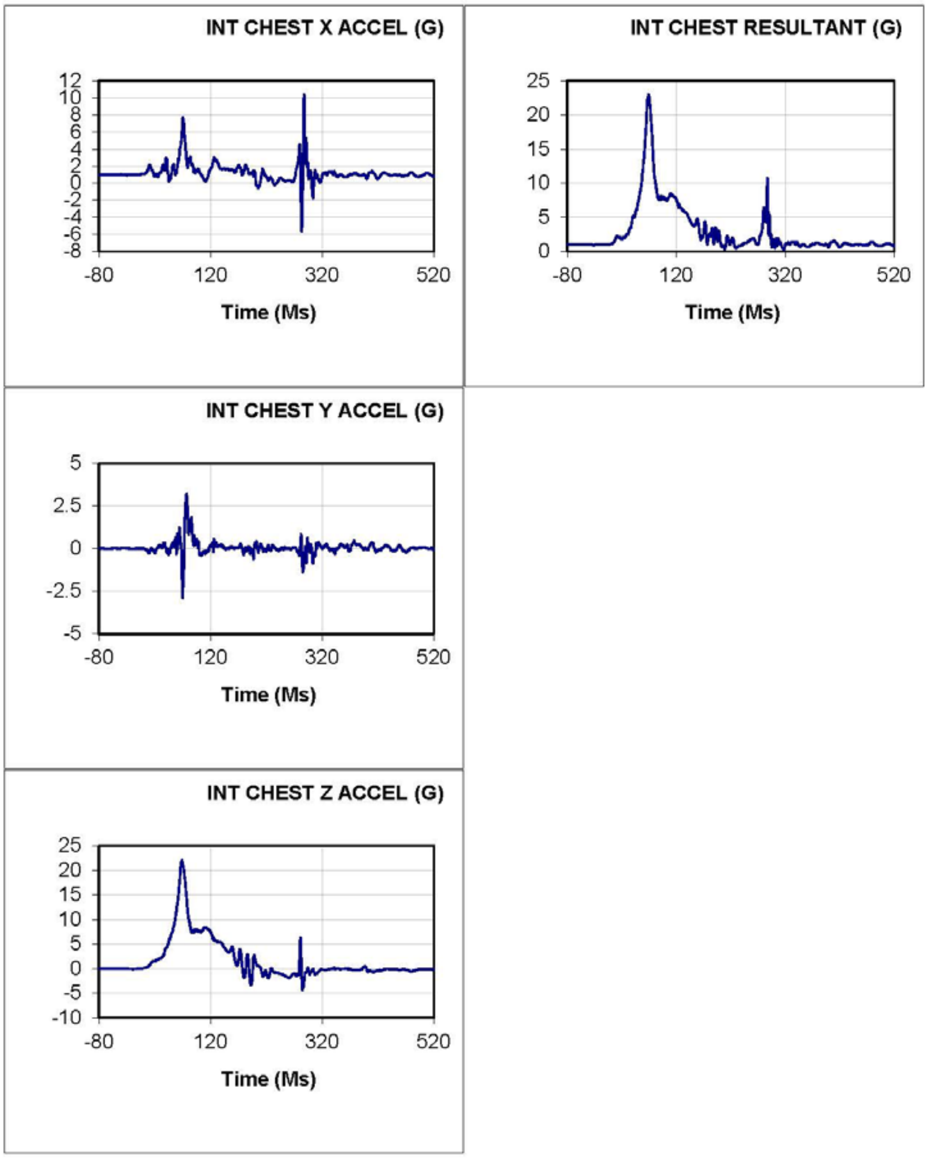
201302 Test: 8667 Test Date: 130124 Subj: THOR Cell: E3



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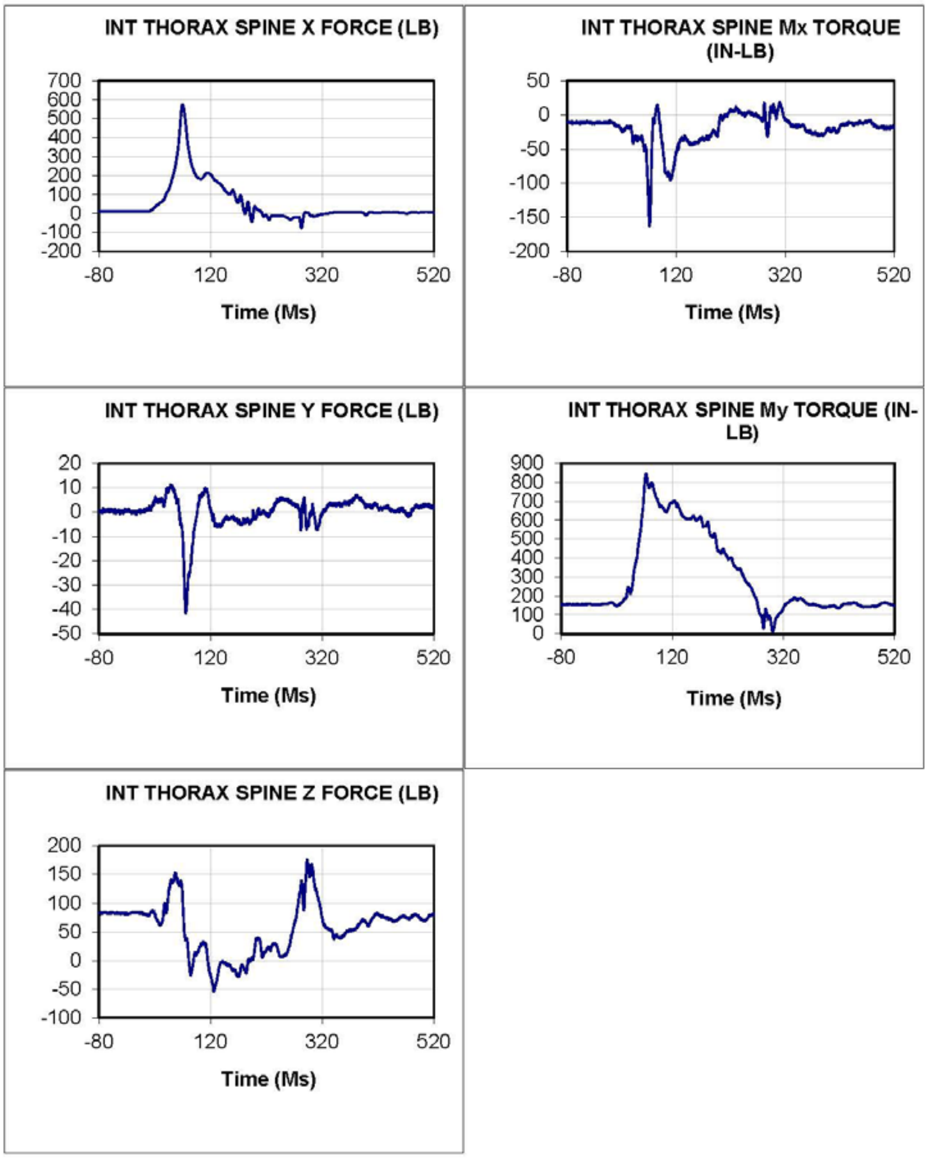
201302 Test: 8667 Test Date: 130124 Subj: THOR Cell: E3



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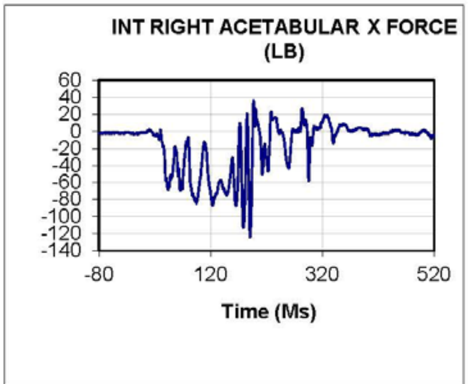
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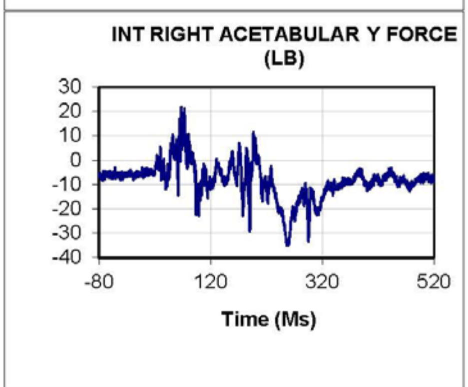
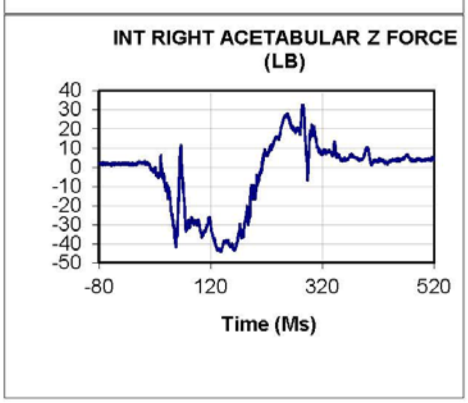
(LB)
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-80
120
320
520
Time (Ms)


INT RIGHT ACETABULAR Y FORCE
(LB)
30
20
10
0
-10
-20
-30
-40
-80
120
320
520
Time (Ms)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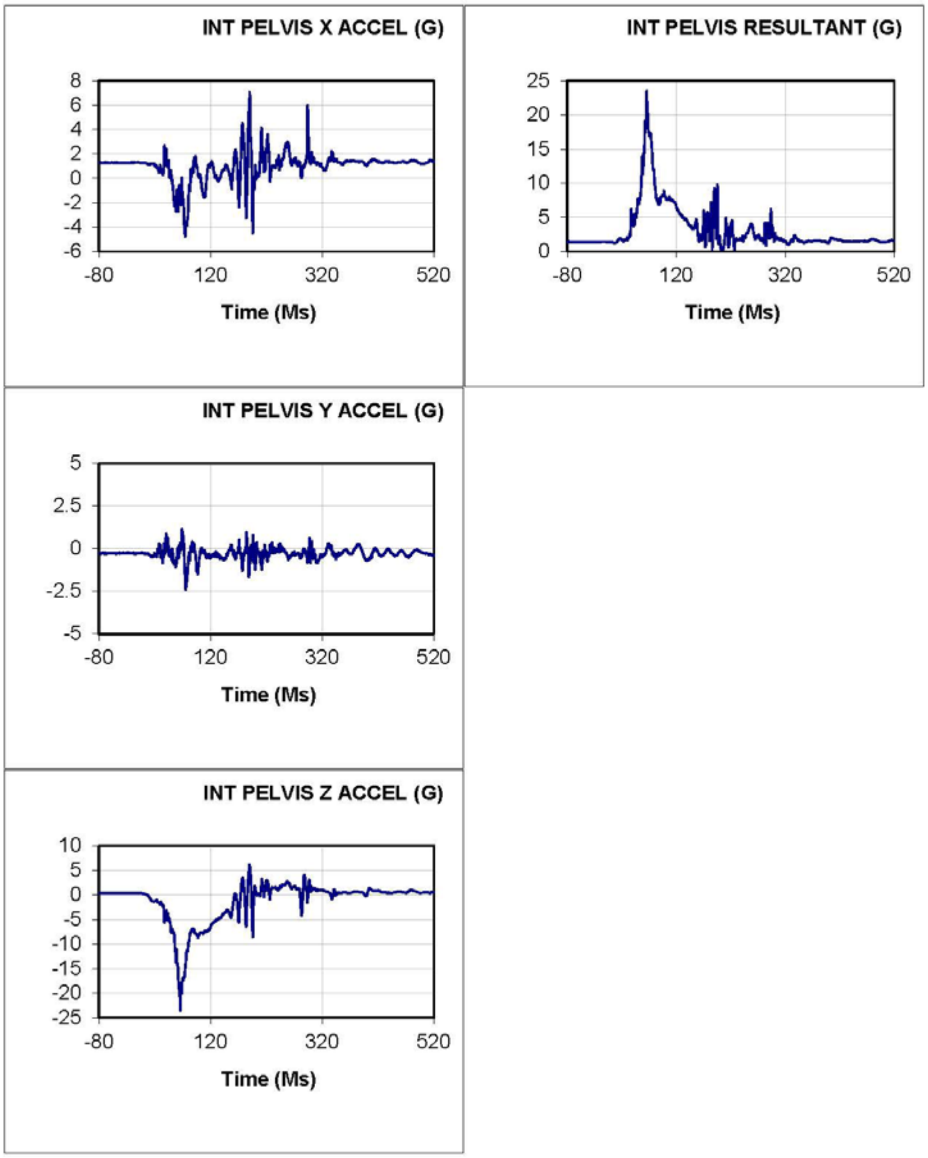
(LB)
40
30
20
10
0
-10
-20
-30
-40
-50
-80
120
320
520
Time (Ms)

201302 Test: 8667 Test Date: 130124 Subj: THOR Cell: E3



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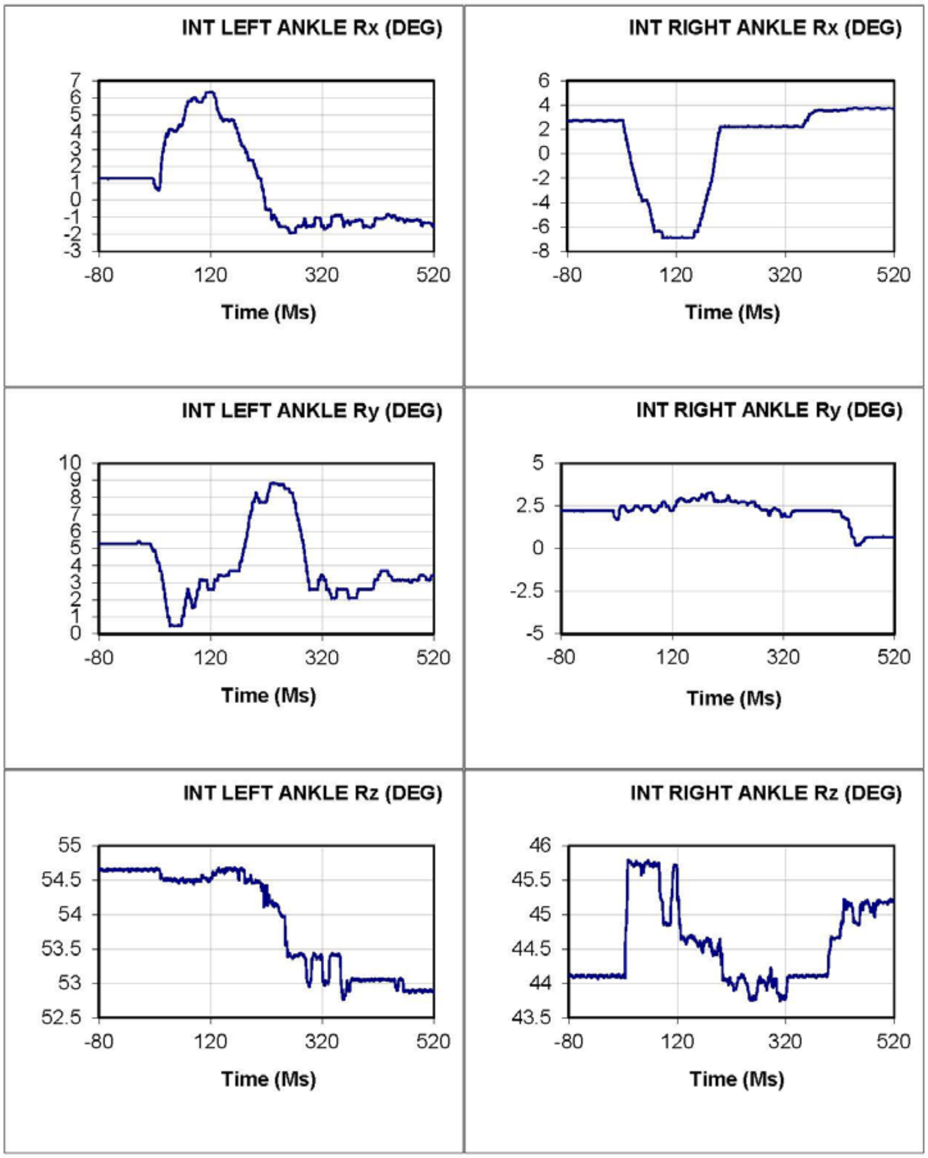
201302 Test: 8667 Test Date: 130124 Subj: THOR Cell: E3



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201302 Test: 8669 Test Date: 130124 Subj: THOR Wt: 174.0
Nom G: 20.0 Cell: E4

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
Reference Mark Time (Ms)				2.2	
Impact Rise Time (Ms)				53.8	
Impact Duration (Ms)				122.2	
Velocity Change (Ft/Sec)		55.12			
SLED X ACCEL (G)	0.02	21.44	-0.67	53.8	289.3
SLED VELOCITY (FT/SEC)	-0.07	51.87	-0.05	373.6	0.0
INTEGRATED ACCEL (FT/SEC)	0.01	55.12	0.04	122.2	0.0
LEFT HEADREST X FORCE (LB)	4.03	1424.07	-137.00	281.5	288.3
RIGHT HEADREST X FORCE (LB)	6.61	835.36	-171.00	281.5	293.6
CT HEADREST X FORCE (LB)	-9.02	168.96	-59.99	280.6	291.3
HEADREST X SUM (LB)	1.63	2341.37	-269.26	281.5	288.3
LF UPPER BACK X FORCE (LB)	30.24	308.60	-19.59	48.1	91.3
RT UPPER BACK X FORCE (LB)	34.17	380.34	-31.03	48.0	283.0
CT UPPER BACK X FORCE (LB)	16.02	292.01	-144.45	288.1	281.5
UPPER BACKPLATE X SUM (LB)	80.42	716.94	-69.11	288.1	81.6
LF LOWER BACK X FORCE (LB)	25.09	444.05	-133.12	64.3	283.9
RT LOWER BACK X FORCE (LB)	25.21	557.21	-81.08	42.6	283.8
CT LOWER BACK X FORCE (LB)	18.64	884.92	-94.48	43.5	285.2
LOWER BACKPLATE X SUM (LB)	68.94	1488.59	-206.11	44.1	284.0
LEFT SEAT PAN Z FORCE (LB)	10.42	881.84	-353.28	45.8	304.3
RIGHT SEAT PAN Z FORCE (LB)	5.23	1017.56	-111.60	45.1	291.3
CENTER SEAT PAN Z FORCE (LB)	30.60	3291.79	-127.98	40.3	288.3
SEAT PAN Z SUM (LB)	46.25	4998.94	-246.87	42.2	291.9
SEAT PAN Z MINUS TARE (LB)	46.63	5487.68	-256.07	42.2	291.9
LEFT SHOULDER X FORCE (LB)	-9.63	66.51	-69.86	283.7	89.1
LEFT SHOULDER Y FORCE (LB)	3.80	62.39	-90.95	283.4	282.3
LEFT SHOULDER Z FORCE (LB)	6.13	71.06	-33.88	85.3	291.6
LEFT SHOULDER RES (LB)	12.05	103.42	1.66	282.3	302.4
RIGHT SHOULDER X FORCE (LB)	-12.69	69.78	-56.98	284.1	281.4
RIGHT SHOULDER Y FORCE (LB)	-3.91	64.46	-62.86	282.1	283.6
RIGHT SHOULDER Z FORCE (LB)	1.70	53.83	-22.61	62.5	294.3
RIGHT SHOULDER RES (LB)	13.41	82.35	0.95	284.2	310.4
LEFT LAP X FORCE (LB)	-16.23	42.40	-64.93	39.1	302.2
LEFT LAP Y FORCE (LB)	-0.78	19.83	-55.78	38.6	37.7
LEFT LAP Z FORCE (LB)	-7.79	37.83	-38.23	38.2	301.3

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201302 Test: 8669 Test Date: 130124 Subj: THOR Wt: 174.0
Nom G: 20.0 Cell: E4

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
LEFT LAP RESULTANT (LB)	18.03	73.20	1.47	302.3	6.8
RIGHT LAP X FORCE (LB)	-9.41	40.72	-53.24	57.9	353.4
RIGHT LAP Y FORCE (LB)	3.72	19.70	-6.80	57.8	287.7
RIGHT LAP Z FORCE (LB)	-10.00	21.81	-44.83	58.6	285.6
RIGHT LAP RESULTANT (LB)	14.24	64.15	6.37	300.5	7.5
CROTCH STRAP X FORCE (LB)	4.13	13.95	-33.70	345.1	33.9
CROTCH STRAP Y FORCE (LB)	-1.92	6.61	-11.88	33.8	36.4
CROTCH STRAP Z FORCE (LB)	-22.07	42.59	-64.36	39.6	143.7
CROTCH STRAP FORCE (LB)	22.55	64.74	1.52	143.7	105.5
RIGHT HEADREST Y FORCE (LB)	-9.19	-0.79	-6950.14	118.6	288.1
RT SHOULDER PLATE Y (LB)	-2.10	5.99	-1888.23	238.8	304.6
RIGHT PELVIS PLATE Y FORCE (LB	-4.19	9.47	-6823.08	58.7	304.7
INT HEAD X ACCEL (G)	1.01	133.80	-13.05	280.2	138.8
INT HEAD Y ACCEL (G)	0.00	3.32	-10.31	283.5	282.1
INT HEAD Z ACCEL (G)	-0.01	55.42	-41.65	46.7	282.9
INT HEAD RESULTANT (G)	1.01	133.94	0.07	280.2	437.2
INT HEAD HIC		437.06		279.6	282.5
INT HEAD Rx ANG (RAD/SEC2)	-2.43	290.71	-173.00	53.7	118.7
INT HEAD Ry ANG (RAD/SEC2)	1.08	1835.43	-1017.88	103.1	216.8
INT HEAD Rz ANG (RAD/SEC2)	0.71	91.85	-196.26	280.7	107.8
INT NECK X FORCE (LB)	-8.78	18.41	-151.41	278.2	135.0
INT NECK Y FORCE (LB)	0.44	9.41	-36.14	281.5	48.7
INT NECK Z FORCE (LB)	5.80	416.70	-668.45	282.1	46.8
INT NECK RESULTANT (LB)	10.55	669.84	1.33	46.8	378.6
INT NECK Mx TORQUE (IN-LB)	-1.21	87.33	-119.11	48.5	56.8
INT NECK My TORQUE (IN-LB)	2.79	145.75	-71.10	131.0	291.1
INT NECK Mz TORQUE (IN-LB)	-4.75	17.95	-15.07	88.8	41.3
INT NECK TORQUE RES (IN-LB)	5.67	146.10	0.64	131.0	341.3
INT LOWER NECK X FORCE (LB)	-6.39	134.29	-157.19	47.2	141.2
INT LOWER NECK Y FORCE (LB)	-2.57	17.56	-48.53	62.9	45.6
INT LOWER NECK Z FORCE (LB)	2.05	426.22	-829.86	282.6	46.8
INT LOWER NECK RES (LB)	7.25	840.49	1.08	46.8	18.0
INT LOWER NECK Mx (IN-LB)	-4.58	27.46	-157.47	281.6	48.4
INT LOWER NECK My (IN-LB)	53.83	912.73	-286.25	139.6	48.3
INT LOWER NECK Mz (IN-LB)	-1.54	21.24	-29.69	160.9	61.5

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201302 Test: 8669 Test Date: 130124 Subj: THOR Wt: 174.0
Nom G: 20.0 Cell: E4

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT LOWER NECK RES (IN-LB)	54.05	912.78	4.00	139.6	35.8
INT NECK SPRING FRONT FORCE (	-12.21	11.84	-19.72	282.3	144.9
INT NECK SPRING REAR FORCE (L	-0.26	145.05	-4.49	137.7	285.7
INT OC Ry ANGLE (DEG)	90.13	102.66	83.13	294.6	320.9
INT UPPER LT THORAX DX (MM)	81.64	86.97	78.50	81.2	297.9
INT UPPER LT THORAX RY (DEG)	4.19	8.85	-3.37	150.4	56.4
INT UPPER LT THORAX RZ (DEG)	7.73	9.22	6.78	151.1	50.6
INT UPPER RT THORAX DX (MM)	83.98	90.49	81.41	86.7	304.1
INT UPPER RT THORAX RY (DEG)	2.25	8.04	-5.67	157.5	54.3
INT UPPER RT THORAX RZ (DEG)	-13.02	-11.54	-13.92	150.6	50.9
INT LOWER LT THORAX DX (MM)	127.08	129.89	99.20	316.7	69.3
INT LOWER LT THORAX RY (DEG)	19.19	19.24	-1.69	18.1	74.8
INT LOWER LT THORAX RZ (DEG)	5.79	8.29	3.98	264.6	218.4
INT LOWER RT THORAX DX (MM)	122.64	127.60	99.62	325.5	69.7
INT LOWER RT THORAX RY (DEG)	18.76	19.32	2.43	338.4	73.5
INT LOWER RT THORAX RZ (DEG)	-10.41	-8.53	-14.11	324.5	51.8
INT LEFT CLAVICLE MFX (LB)	1.78	12.14	-5.34	40.7	115.6
INT LEFT CLAVICLE MFZ FORCE (L	1.05	3.94	-22.61	115.2	56.4
INT LEFT CLAVICLE LFX FORCE (LB	-1.04	8.49	-9.56	115.7	42.8
INT LEFT CLAVICLE LFZ FORCE (LB	-0.86	11.59	-3.63	47.4	115.7
INT STERNUM X ACCEL (G)	1.01	111.24	-109.89	51.3	62.6
INT T1 X ACCEL (G)	1.03	19.36	-36.22	48.4	43.1
INT T1 Y ACCEL (G)	0.00	33.52	-14.66	43.7	49.0
INT T1 Z ACCEL (G)	0.00	70.18	-10.05	44.0	285.8
INT T2 X ACCEL (G)	1.00	25.23	-20.76	47.4	41.7
INT T2 Y ACCEL (G)	0.00	23.63	-31.79	49.9	49.4
INT T2 Z ACCEL (G)	0.00	91.71	-24.74	49.4	49.9
INT CHEST X ACCEL (G)	1.02	21.98	-8.97	289.4	284.9
INT CHEST Y ACCEL (G)	0.00	9.69	-11.92	50.1	44.6
INT CHEST Z ACCEL (G)	0.00	53.28	-10.16	43.0	243.2
INT CHEST RESULTANT (G)	1.02	53.41	0.07	43.0	268.7
INT THORAX SPINE X FORCE (LB)	11.99	1058.24	-181.70	44.5	244.4
INT THORAX SPINE Y FORCE (LB)	-2.11	43.31	-139.94	83.1	52.4
INT THORAX SPINE Z FORCE (LB)	60.95	449.08	-768.07	43.3	58.9
INT THORAX SPINE Mx (IN-LB)	4.99	76.25	-345.03	294.5	44.9
INT THORAX SPINE My (IN-LB)	172.20	1623.08	-106.93	151.5	302.1

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201302 Test: 8669 Test Date: 130124 Subj: THOR Wt: 174.0
Nom G: 20.0 Cell: E4

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT RIGHT ACETABULAR X (LB)	-2.71	123.66	-214.17	53.2	241.3
INT RIGHT ACETABULAR Y (LB)	-9.62	84.59	-70.76	47.9	63.9
INT RIGHT ACETABULAR Z (LB)	2.12	286.70	-85.43	41.0	128.2
INT PELVIS X ACCEL (G)	1.27	9.94	-11.92	240.0	51.1
INT PELVIS Y ACCEL (G)	-0.27	3.88	-6.09	44.3	238.5
INT PELVIS Z ACCEL (G)	0.40	14.42	-55.42	240.1	41.5
INT PELVIS RESULTANT (G)	1.36	55.58	0.16	41.5	153.5
INT LEFT ANKLE RX (DEG)	2.58	18.73	-3.72	71.4	151.9
INT LEFT ANKLE Ry (DEG)	5.71	11.50	-20.71	177.4	66.7
INT LEFT ANKLE Rz (DEG)	52.54	52.57	44.70	26.0	76.2
INT RIGHT ANKLE Rx (DEG)	1.20	6.34	-17.83	157.0	77.8
INT RIGHT ANKLE Ry (DEG)	1.43	2.83	-5.20	184.2	65.7
INT RIGHT ANKLE Rz (DEG)	40.25	44.71	40.24	406.3	6.6

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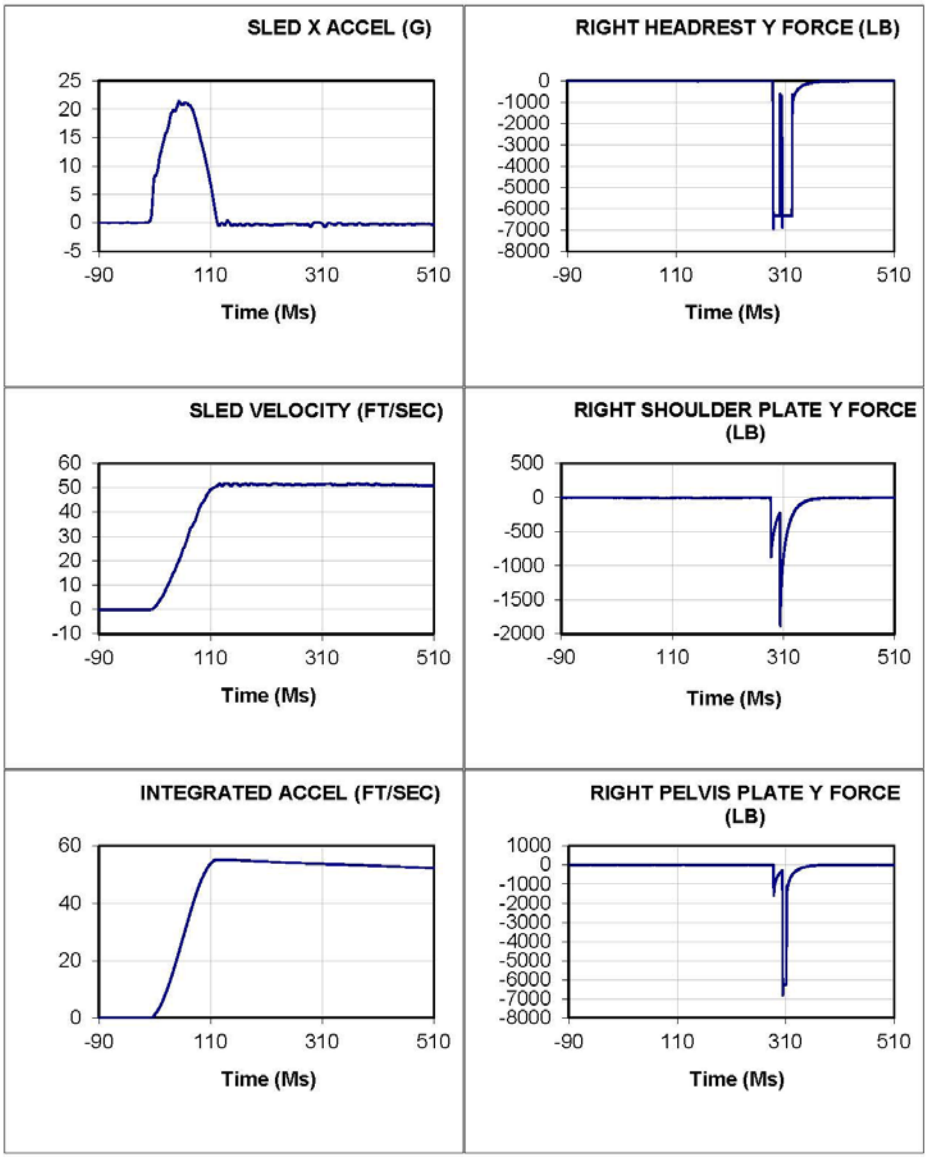
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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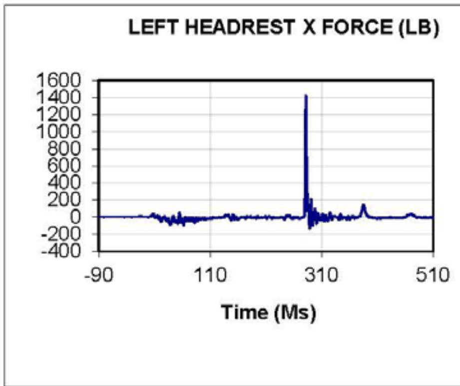
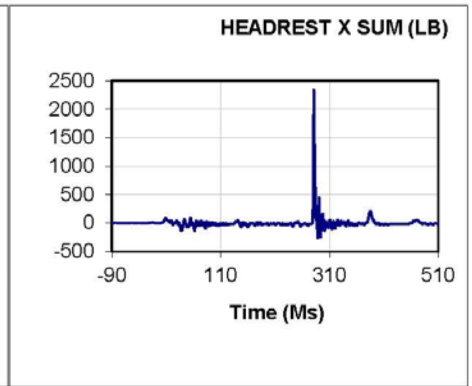
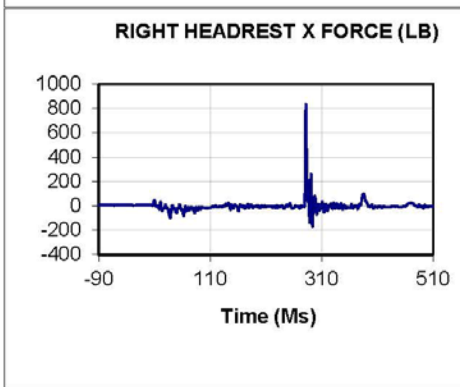
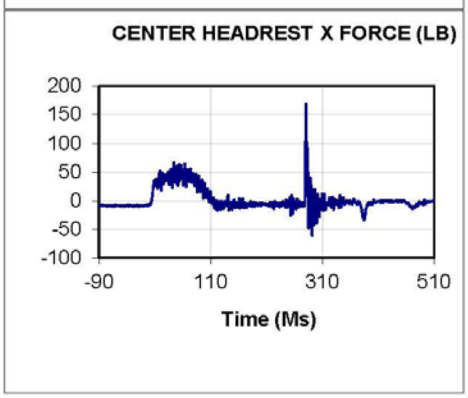
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4









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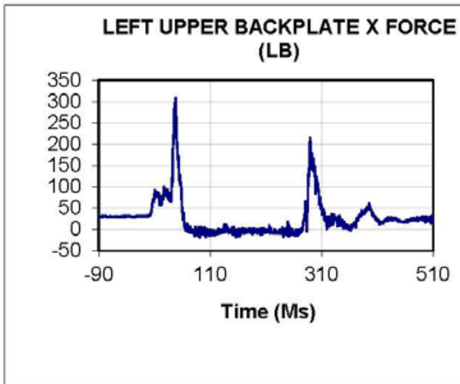
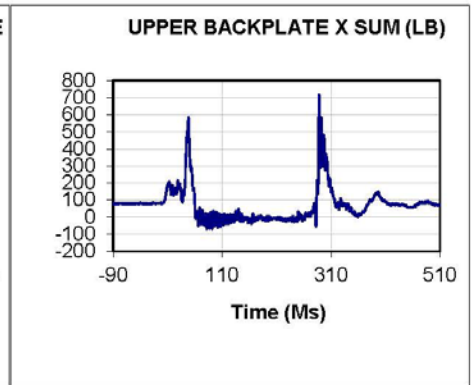
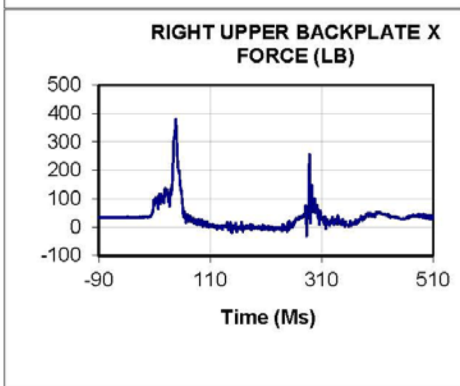
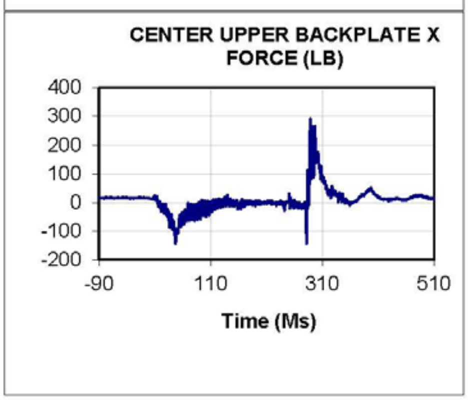
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4









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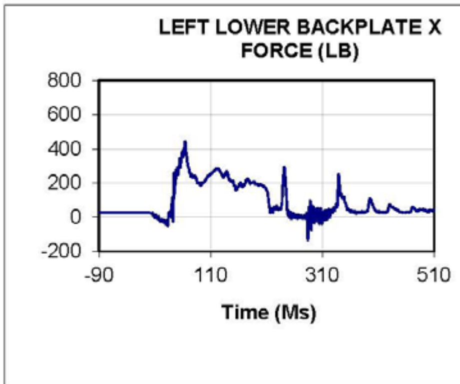
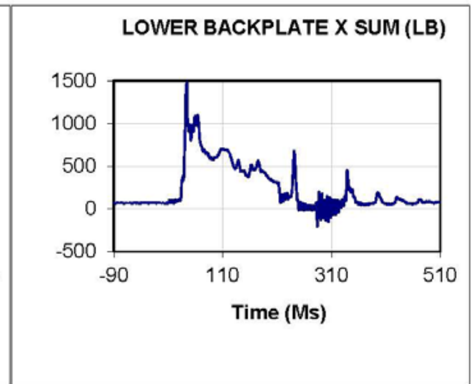
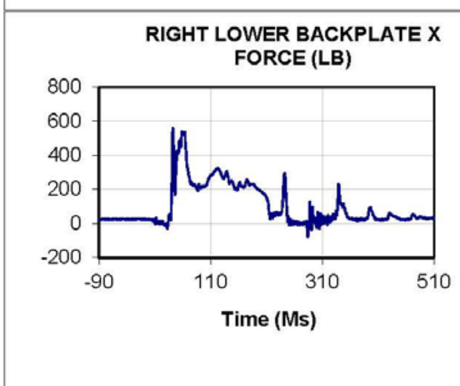
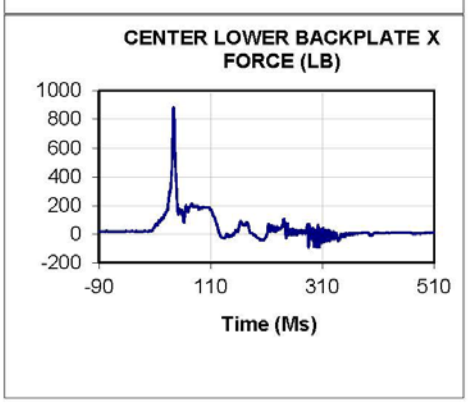
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4









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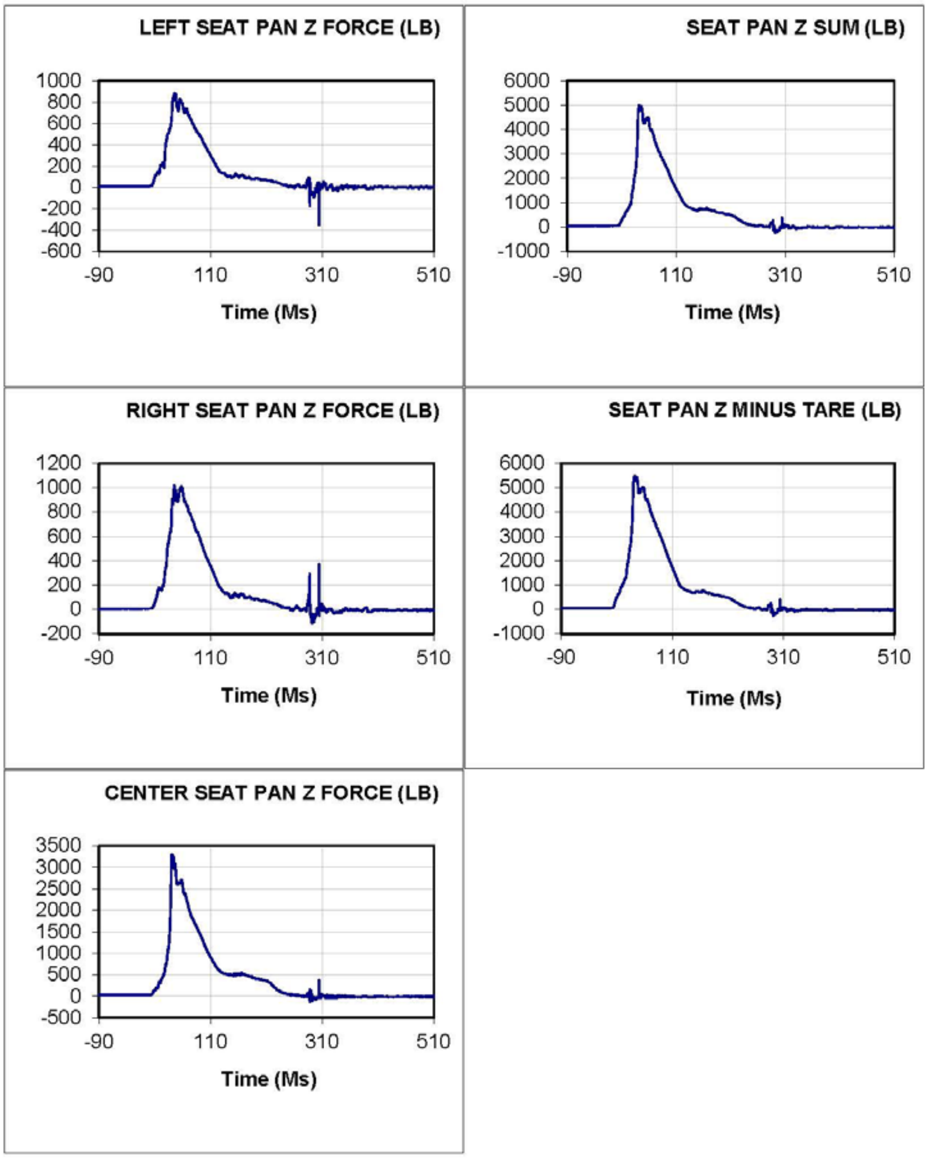
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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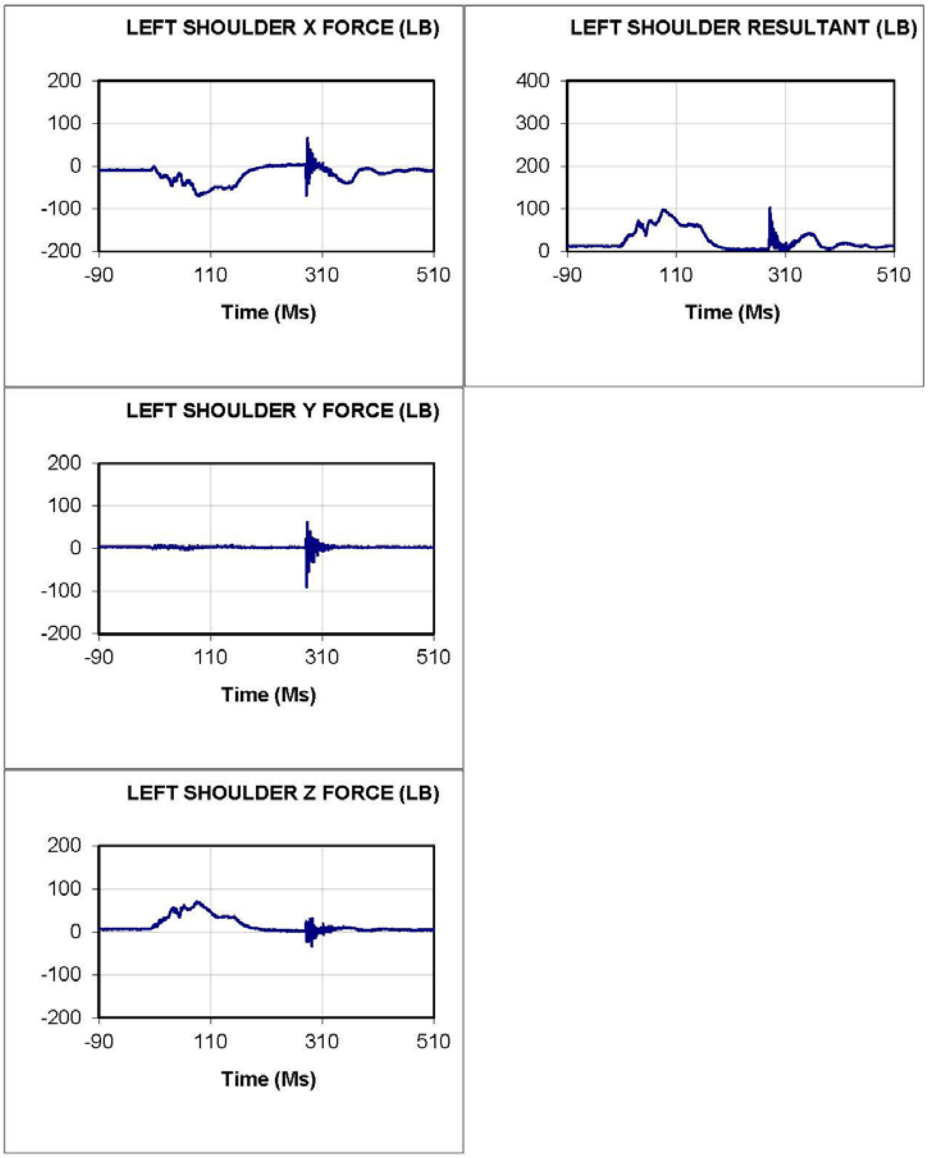

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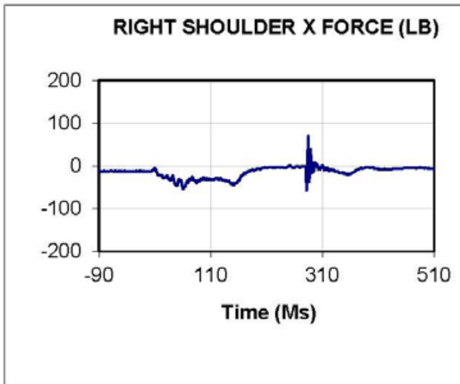
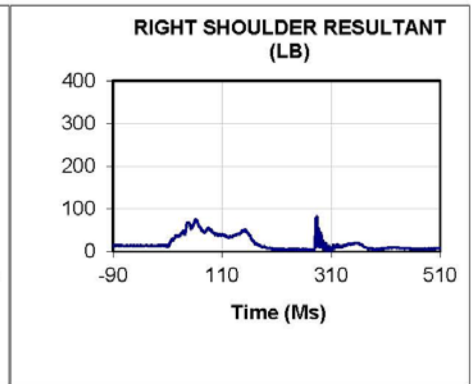
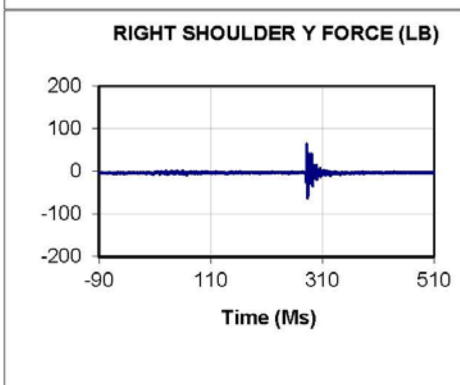
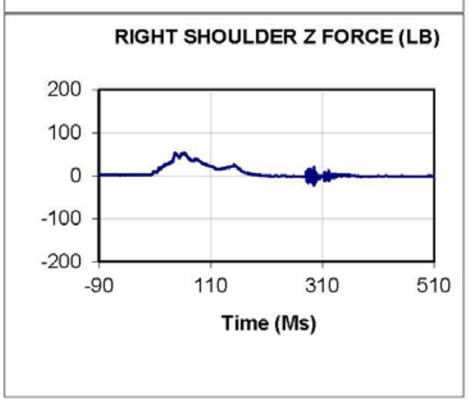
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4









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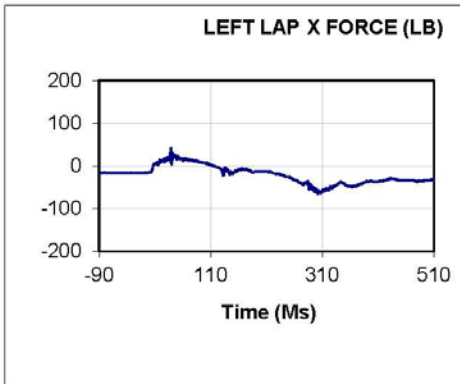

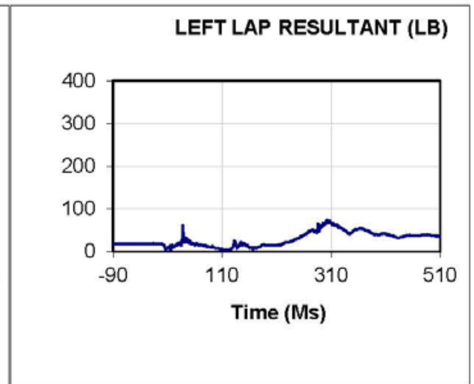

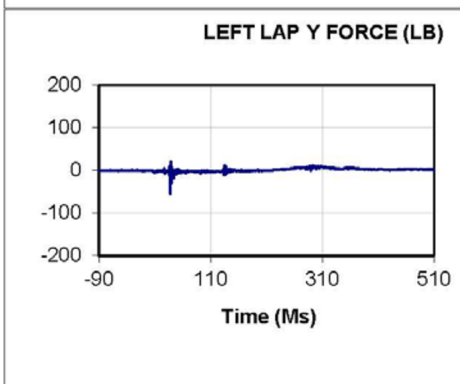

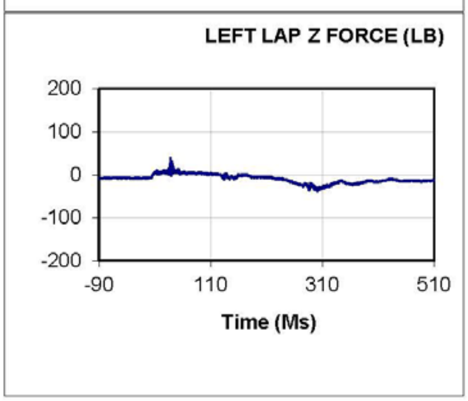

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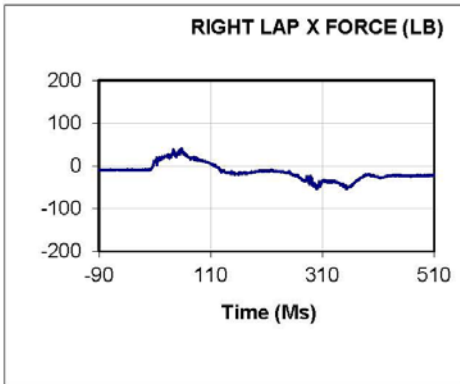
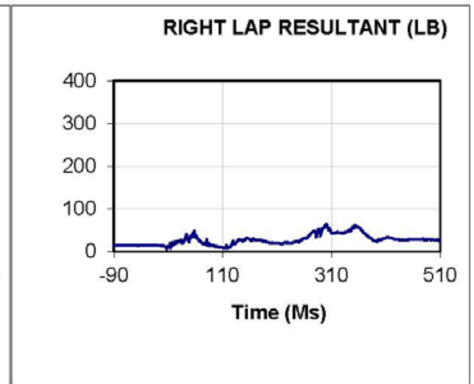
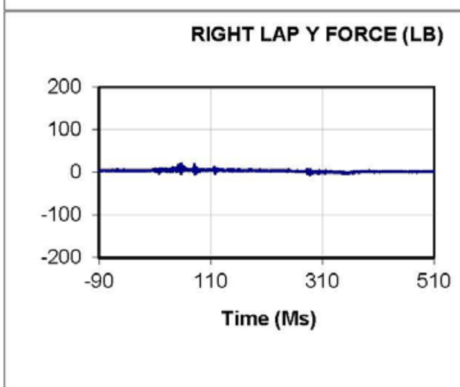
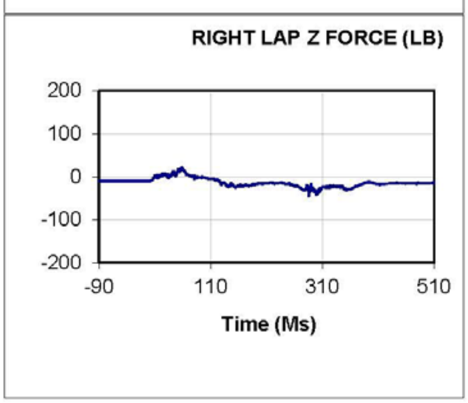
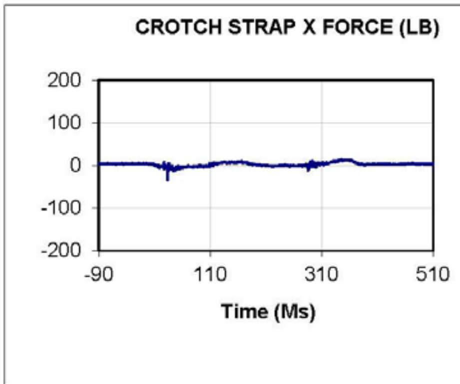

RIGHT LAP X FORCE (LB)
200
100
0
-100
-200
-90
110
310
510
Time (Ms)

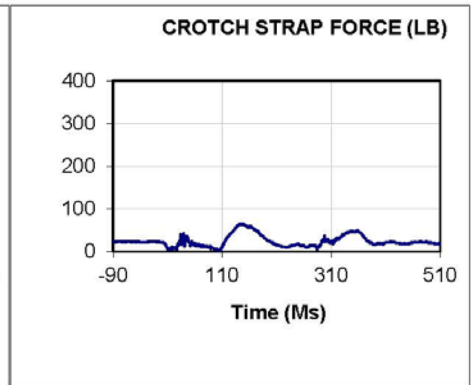

RIGHT LAP RESULTANT (LB)
400
300
200
100
0
-90
110
310
510
Time (Ms)

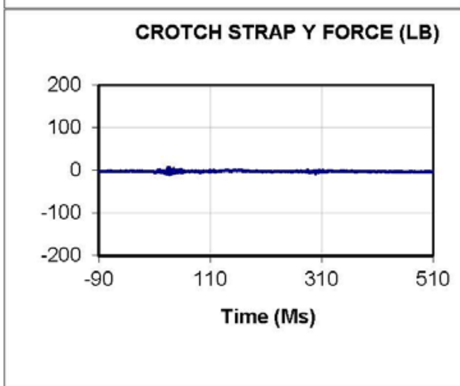

RIGHT LAP Y FORCE (LB)
200
100
0
-100
-200
-90
110
310
510
Time (Ms)

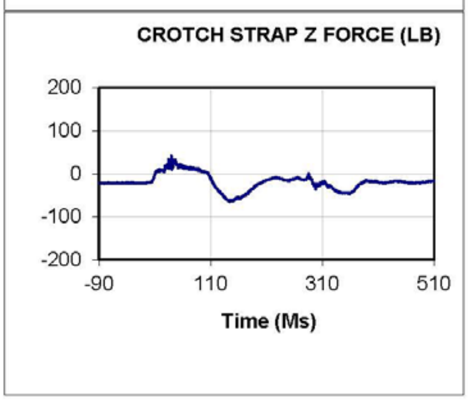

RIGHT LAP Z FORCE (LB)
200
100
0
-100
-200
-90
110
310
510
Time (Ms)

201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4









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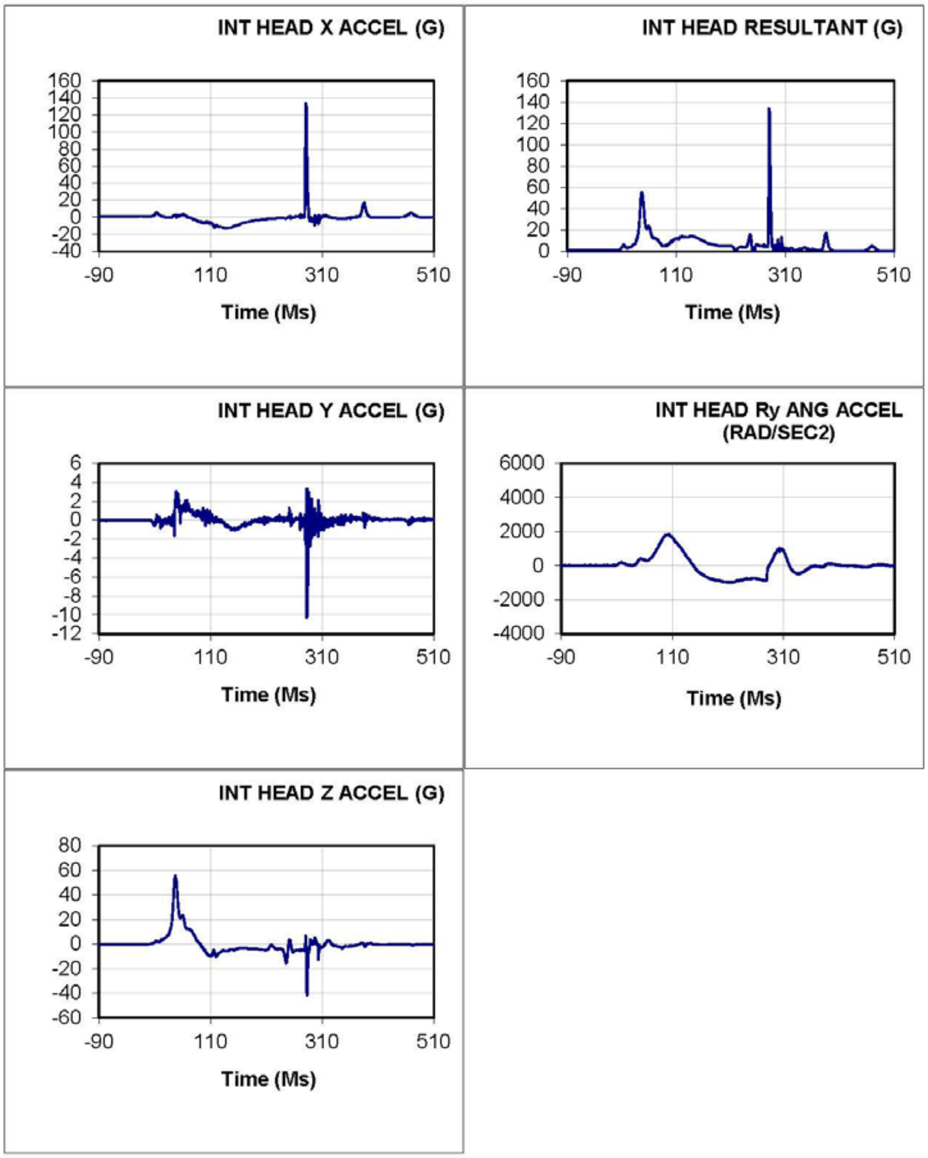
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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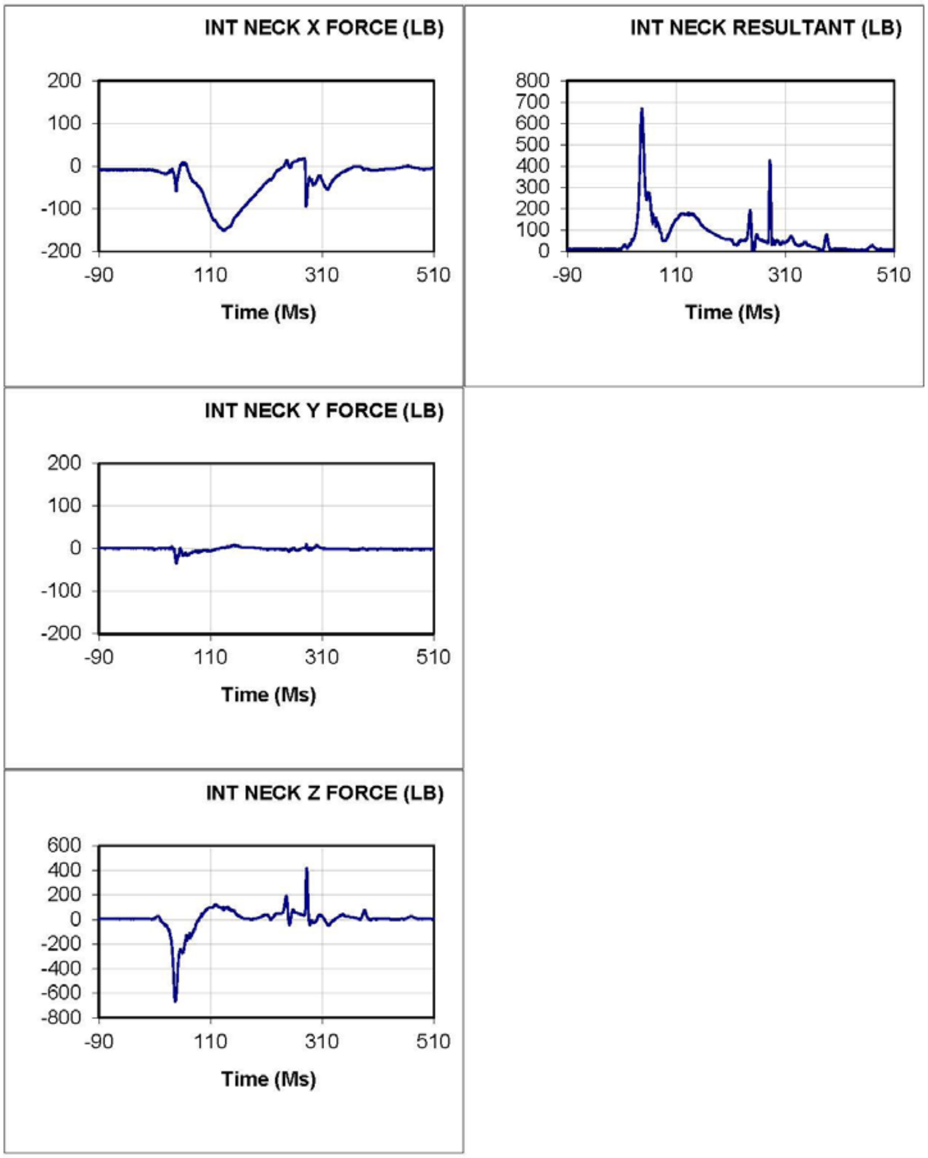
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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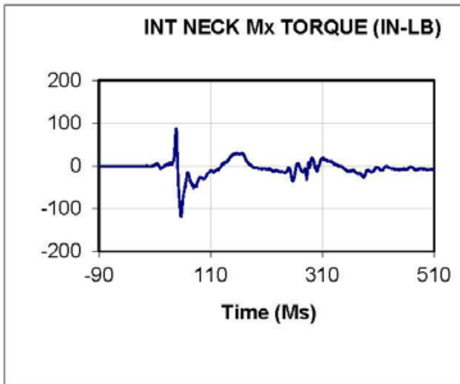
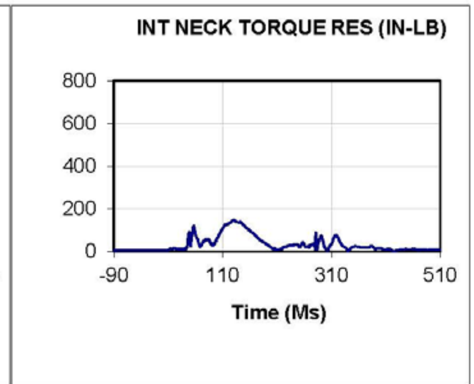
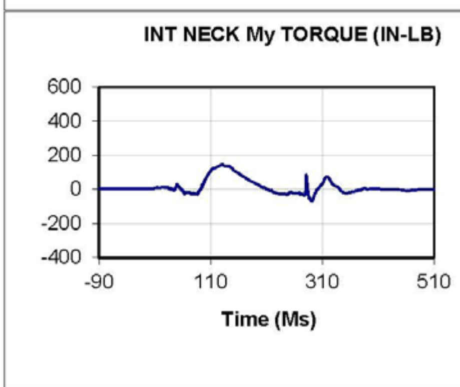
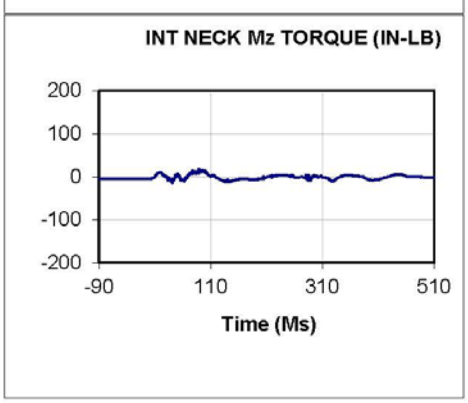
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4









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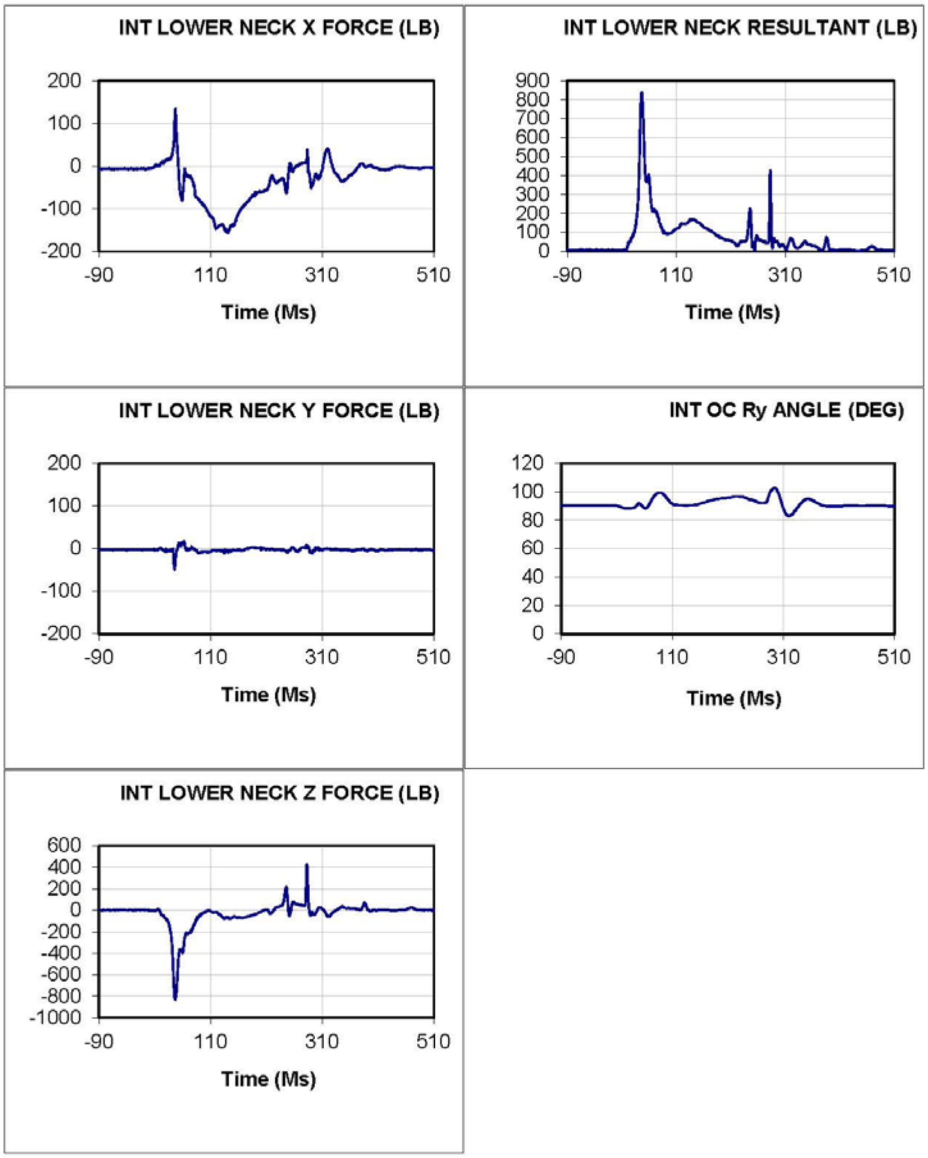
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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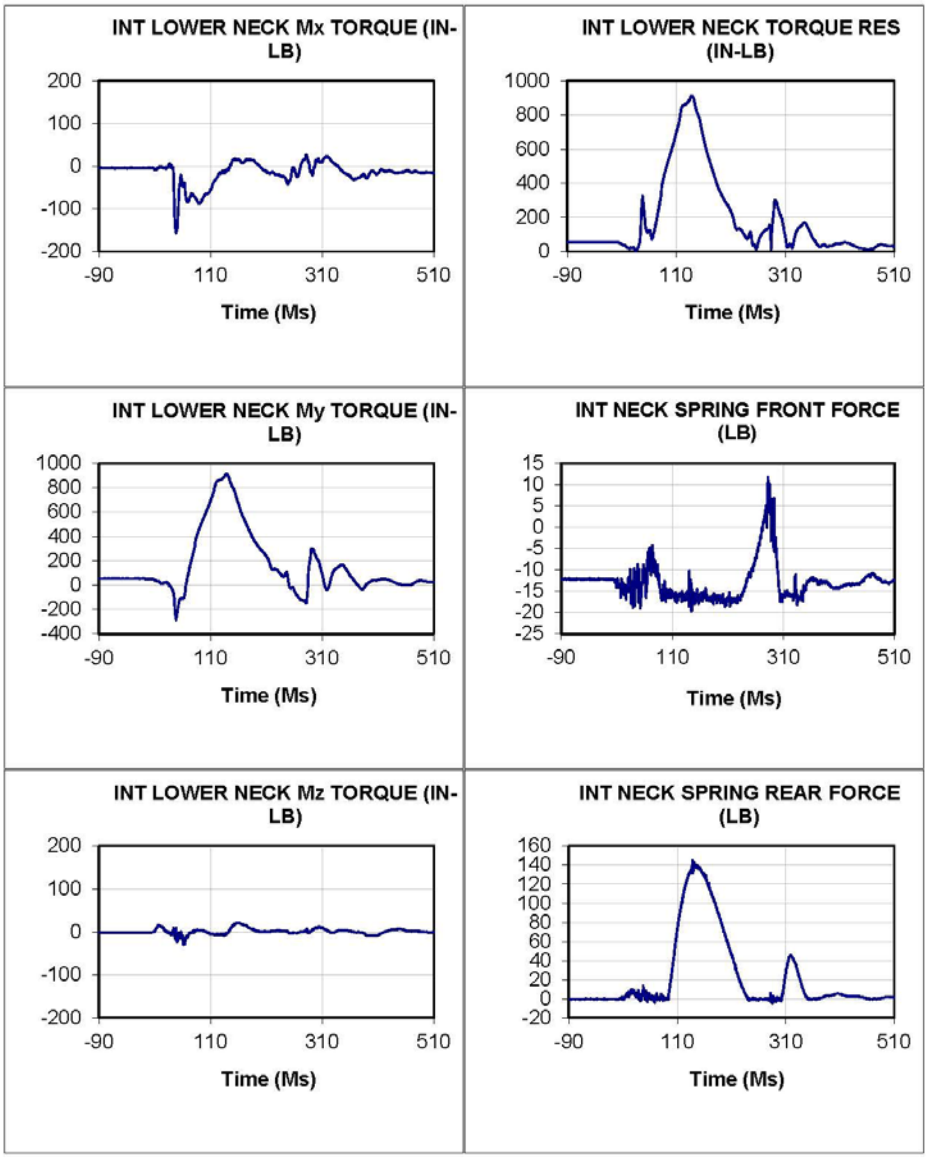
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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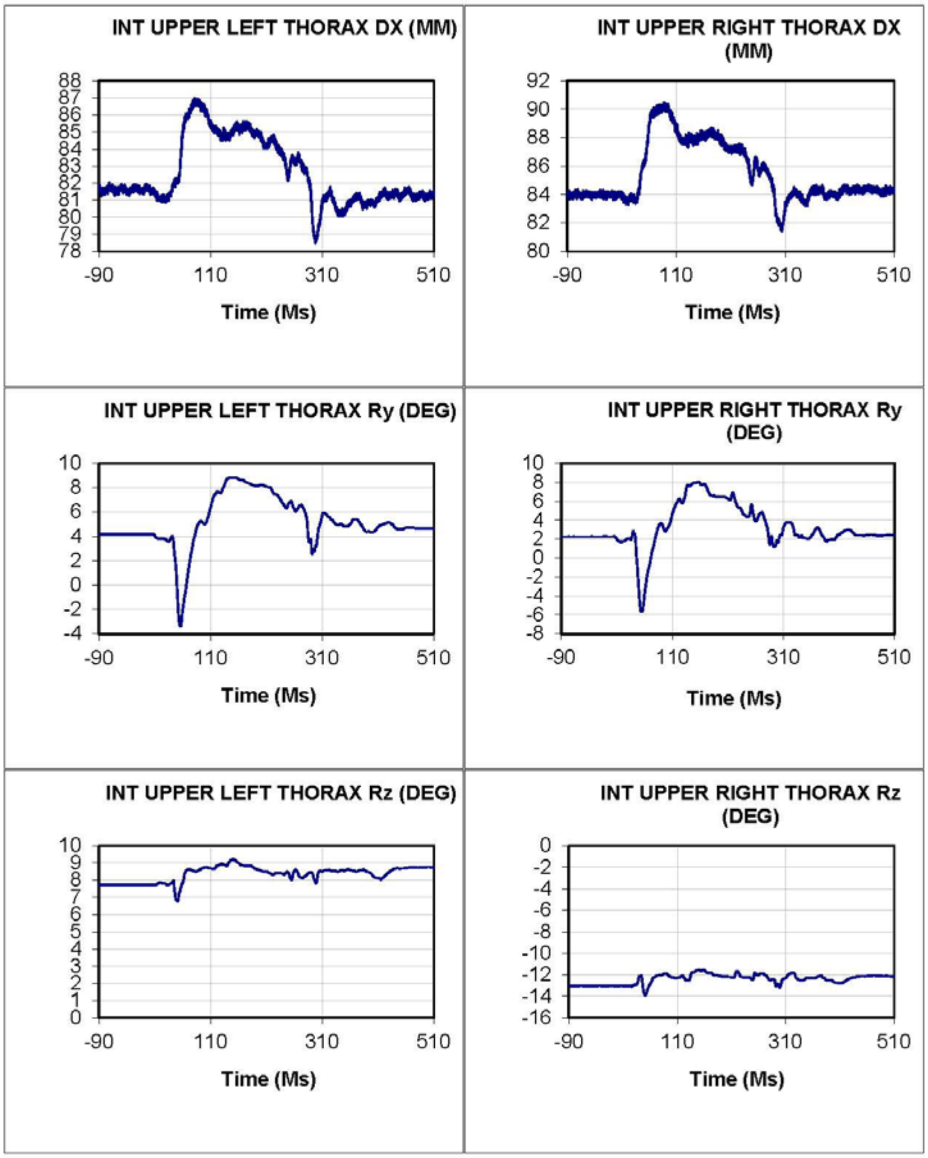
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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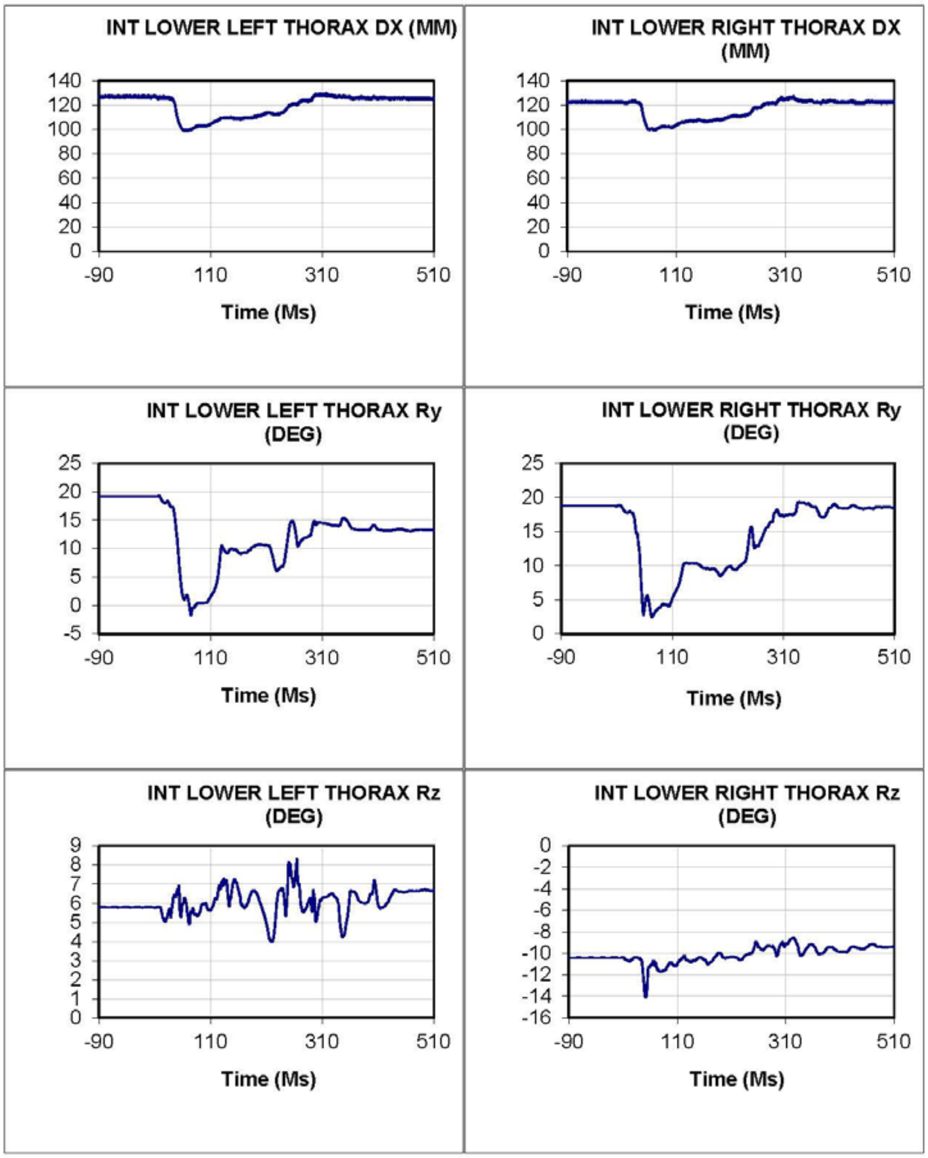
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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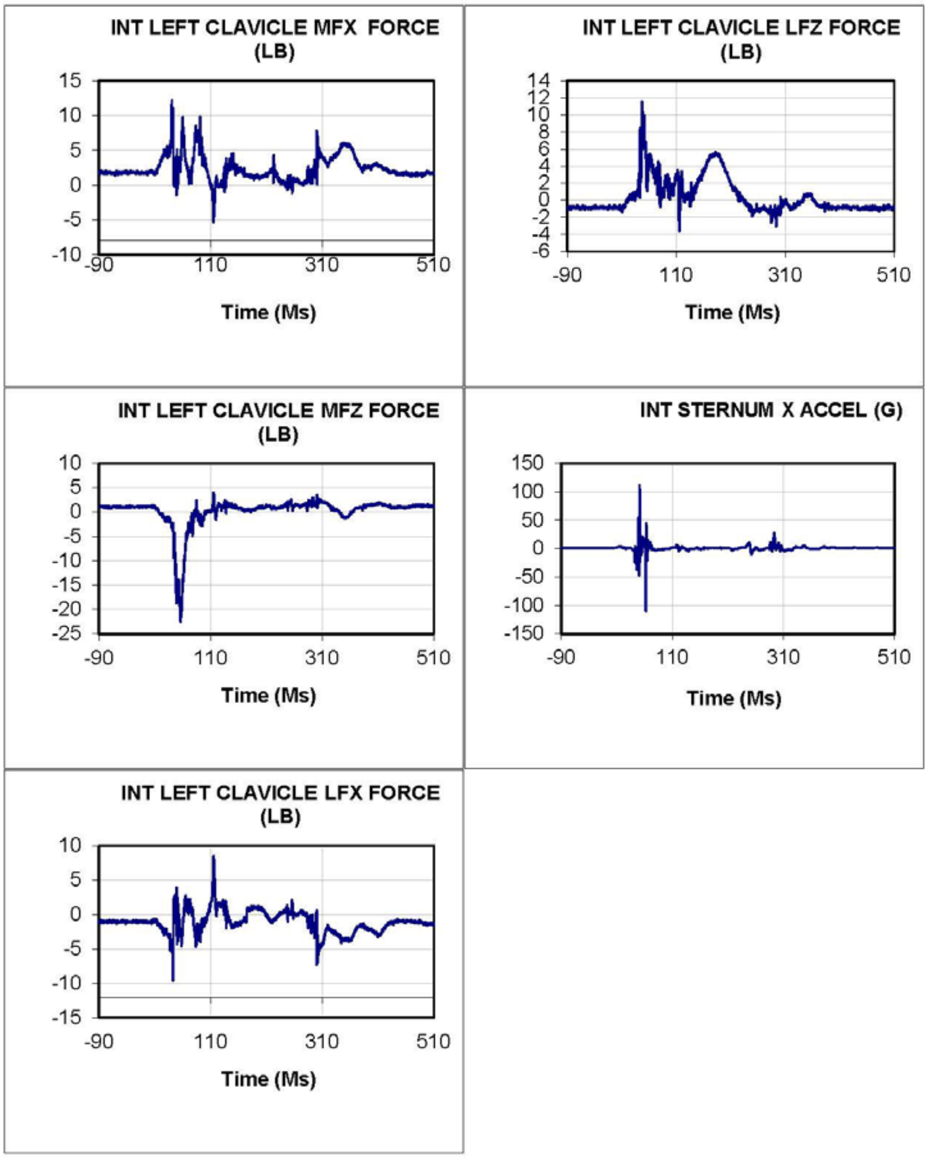
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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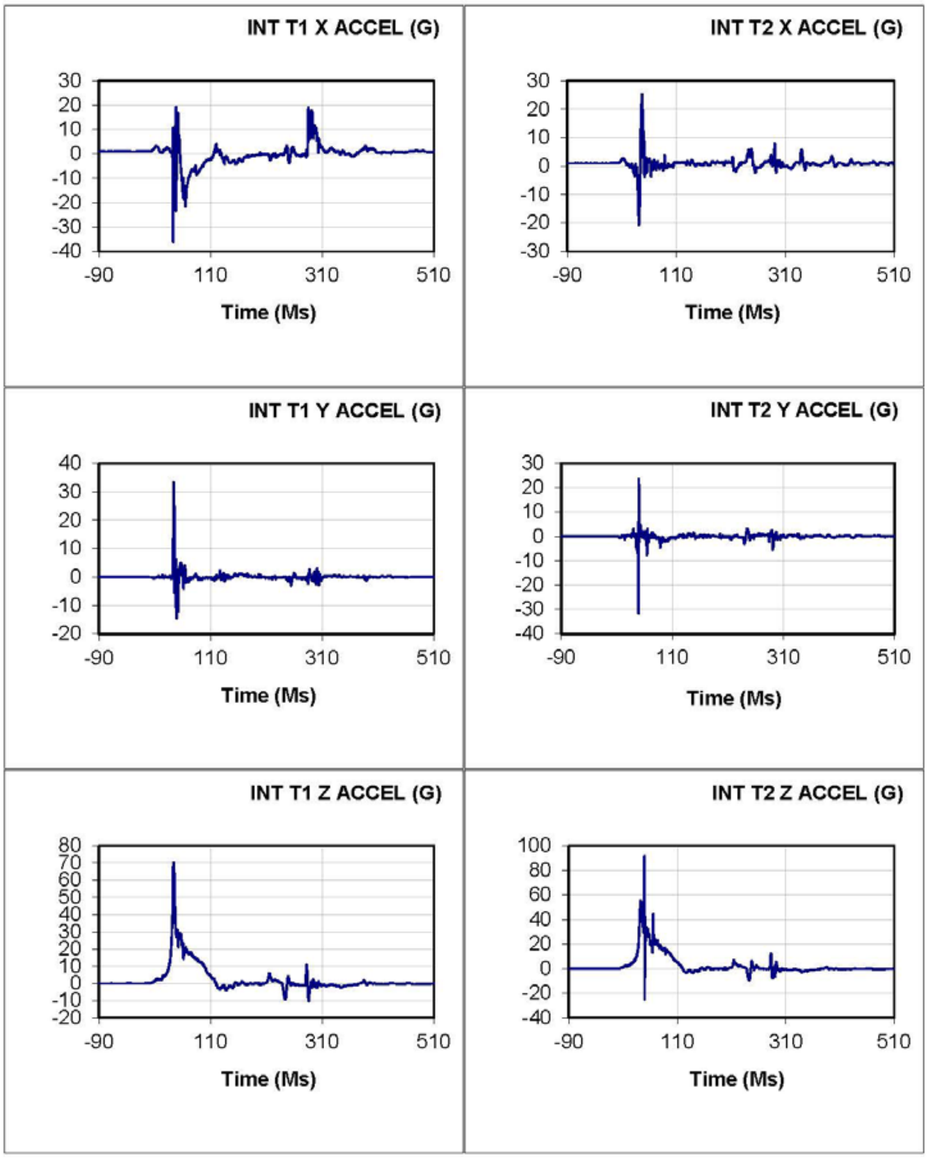
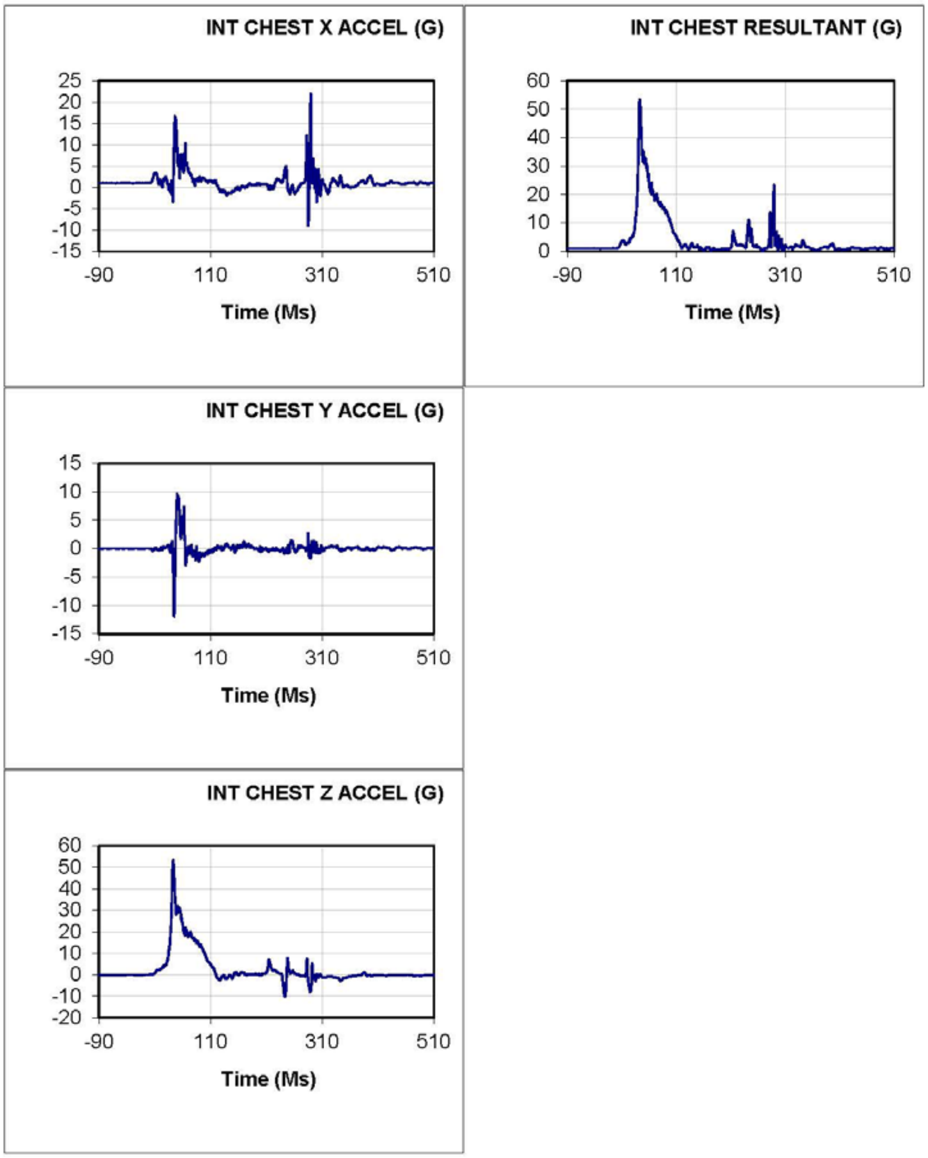
201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4

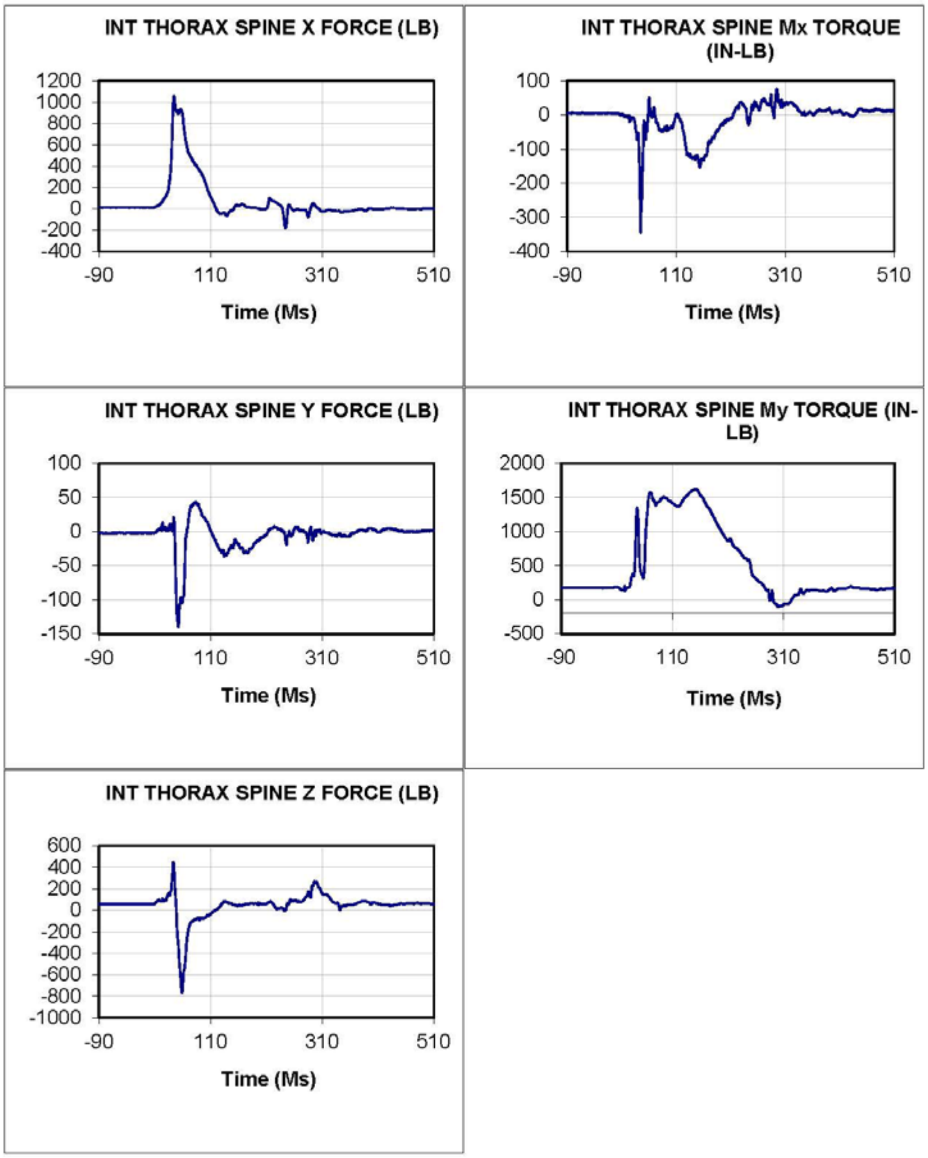


Distribution A: Approved for public release; distribution unlimited.
88 ABW/PA Cleared 02/12/2014; 88ABW-2014-0506.

201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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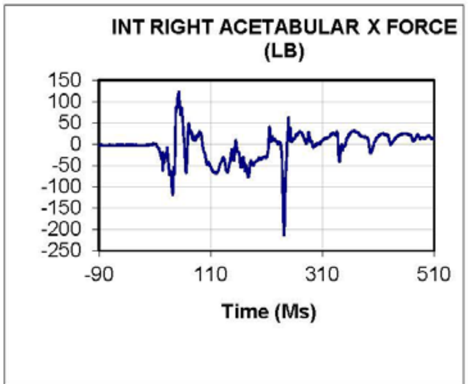
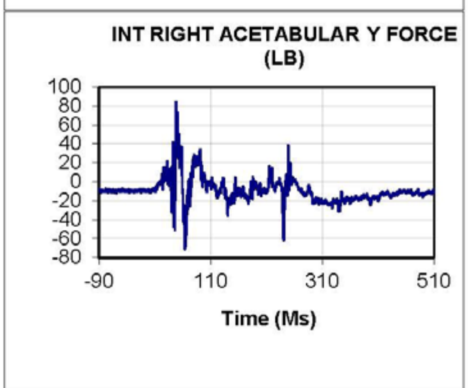
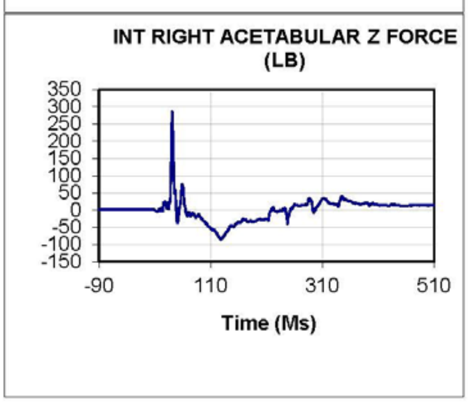
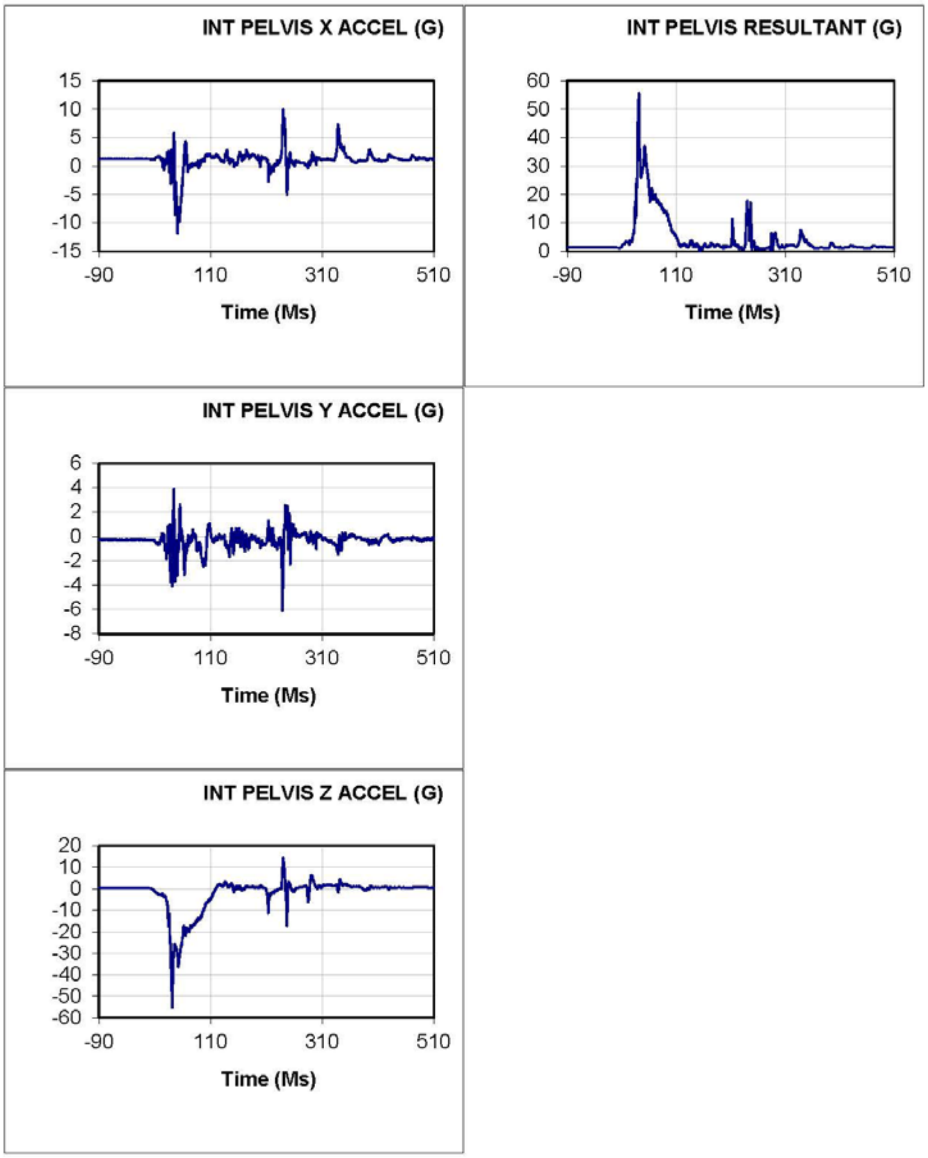

INT RIGHT ACETABULAR X FORCE
(LB)
150
100
50
0
-50
-100
-150
-200
-250
-90
110
310
510
Time (Ms)


INT RIGHT ACETABULAR Y FORCE
(LB)
100
80
60
40
20
0
-20
-40
-60
-80
-90
110
310
510
Time (Ms)

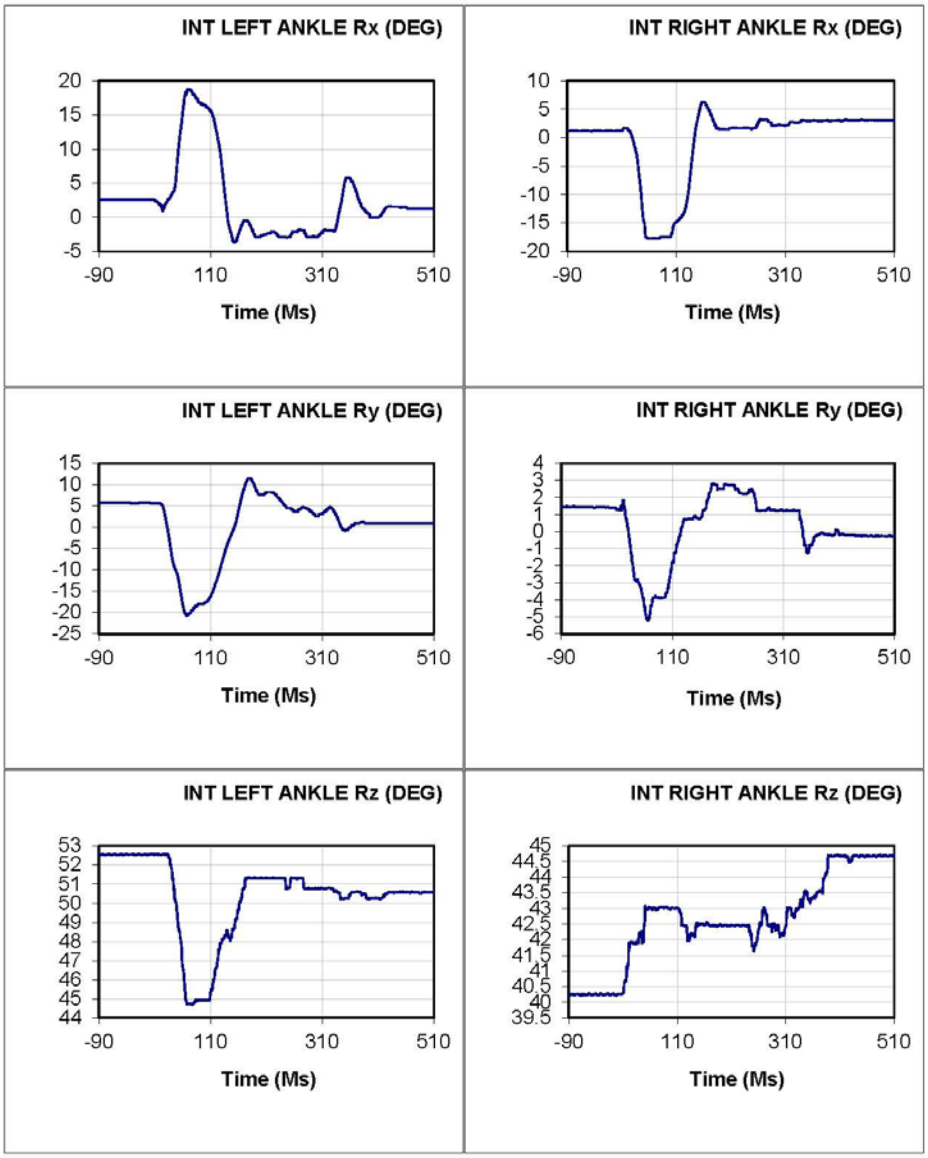

INT RIGHT ACETABULAR Z FORCE
(LB)
350
300
250
200
150
100
50
0
-50
-100
-150
-90
110
310
510
Time (Ms)

201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



Distribution A: Approved for public release; distribution unlimited.
88 ABW/PA Cleared 02/12/2014; 88ABW-2014-0506.

201302 Test: 8669 Test Date: 130124 Subj: THOR Cell: E4



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ATTACHMENT 4: REPRESENTATIVE DATA PRINT-OUTS (-X-AXIS)

- X-Axis Data Examples for THOR-K: Test 8701: Cell D2, 10 G, 70 ms time-to-peak

201302 Test: 8701 Test Date: 130204 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: D2

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
Reference Mark Time (Ms)				3.5	
Impact Rise Time (Ms)				60.3	
Impact Duration (Ms)				171.6	
Velocity Change (Ft/Sec)		36.04			
SLED X ACCEL (G)	0.03	10.00	-0.56	60.3	202.2
SLED VELOCITY (FT/SEC)	-0.06	34.53	-0.03	171.8	0.0
INTEGRATED ACCEL (FT/SEC)	0.01	36.04	0.04	171.6	0.0
LEFT HEADREST X FORCE (LB)	-4.79	1157.08	-79.65	245.2	42.2
RIGHT HEADREST X FORCE (LB)	-3.46	308.77	-173.83	245.3	252.9
CT HEADREST X FORCE (LB)	-3.34	694.20	-68.51	244.8	249.8
HEADREST X SUM (LB)	-11.59	2118.20	-215.58	245.1	252.8
HEADREST X MINUS TARE (LB)	-11.32	2117.85	-219.42	245.1	252.8
LF UPPER BACK X FORCE (LB)	7.98	175.47	-43.01	243.7	62.3
RT UPPER BACK X FORCE (LB)	10.80	222.78	-111.66	252.3	254.5
CT UPPER BACK X FORCE (LB)	-0.55	211.33	-68.74	251.9	248.6
UPPER BACKPLATE X SUM (LB)	18.23	472.38	-124.01	252.0	64.3
UPPER BACK X MINUS TARE (LB)	18.50	468.91	-66.80	252.0	248.8
LF LOWER BACK X FORCE (LB)	8.93	51.71	-85.13	258.3	247.5
RT LOWER BACK X FORCE (LB)	20.40	89.52	-76.05	251.6	249.5
CT LOWER BACK X FORCE (LB)	14.38	63.62	-86.27	262.4	260.3
LOWER BACKPLATE X SUM (LB)	43.71	155.99	-161.35	262.6	260.2
LOWER BACK X MINUS TARE (LB)	43.93	158.08	-159.01	262.6	260.2
LEFT SEAT PAN Z FORCE (LB)	39.82	330.80	-52.40	98.4	271.2
RIGHT SEAT PAN Z FORCE (LB)	39.30	342.31	-58.93	97.1	264.3
CENTER SEAT PAN Z FORCE (LB)	102.68	277.49	-9.31	100.7	268.3
SEAT PAN Z SUM (LB)	181.80	941.41	0.84	100.2	264.0
LEFT SHOULDER X FORCE (LB)	-11.84	52.23	-594.93	247.3	79.2
LEFT SHOULDER Y FORCE (LB)	2.81	51.53	-85.39	247.4	246.0
LEFT SHOULDER Z FORCE (LB)	9.06	266.48	-34.18	83.9	246.3
LEFT SHOULDER RES (LB)	15.19	651.50	0.41	79.3	280.5
RIGHT SHOULDER X FORCE (LB)	-14.30	60.39	-583.95	247.9	77.3
RIGHT SHOULDER Y FORCE (LB)	-3.16	47.61	-51.13	246.0	247.9
RIGHT SHOULDER Z FORCE (LB)	5.96	249.89	-17.61	80.7	247.9
RIGHT SHOULDER RES (LB)	15.83	635.04	0.40	77.4	361.6
LEFT LAP X FORCE (LB)	-15.01	-1.04	-462.65	247.2	79.5

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201302 Test: 8701 Test Date: 130204 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: D2

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
LEFT LAP Y FORCE (LB)	-0.08	199.28	-5.95	81.9	254.6
LEFT LAP Z FORCE (LB)	-8.61	0.55	-659.11	310.8	82.2
LEFT LAP RESULTANT (LB)	17.32	828.07	4.35	81.2	310.6
RIGHT LAP X FORCE (LB)	-10.33	-6.82	-459.92	249.7	78.8
RIGHT LAP Y FORCE (LB)	2.13	8.26	-145.01	265.4	83.2
RIGHT LAP Z FORCE (LB)	-11.53	-5.62	-624.60	257.6	81.9
RIGHT LAP RESULTANT (LB)	15.65	786.43	16.09	81.3	256.9
CROTCH STRAP X FORCE (LB)	1.97	7.37	-80.63	256.6	85.6
CROTCH STRAP Y FORCE (LB)	-1.62	6.79	-8.73	259.6	256.8
CROTCH STRAP Z FORCE (LB)	-15.02	1.88	-195.96	326.8	69.4
CROTCH STRAP FORCE (LB)	15.25	203.30	1.23	72.0	352.8
RIGHT HEADREST Y FORCE (LB)	-998.99	92.61	-1224.80	90.1	439.1
RT SHOULDER PLATE Y (LB)	-227.73	1545.59	-448.03	67.7	419.1
RIGHT PELVIS Y FORCE (LB)	-355.20	1584.90	-501.25	73.8	418.2
INT HEAD X ACCEL (G)	-0.02	130.97	-16.85	243.9	128.1
INT HEAD Y ACCEL (G)	0.00	9.99	-9.93	245.5	246.5
INT HEAD Z ACCEL (G)	0.99	21.15	-33.53	244.1	246.4
INT HEAD RESULTANT (G)	0.99	132.50	0.29	243.9	20.9
INT HEAD HIC		372.97		243.2	246.0
INT HEAD Rx ANG (RAD/SEC2)	-4.21	293.94	-83.65	245.5	165.4
INT HEAD Ry ANG (RAD/SEC2)	0.07	1511.30	-920.98	93.5	178.0
INT HEAD Rz ANG (RAD/SEC2)	-0.47	110.67	-147.51	255.0	246.2
INT NECK X FORCE (LB)	0.46	17.23	-169.35	241.2	126.2
INT NECK Y FORCE (LB)	0.45	21.16	-11.77	59.1	218.2
INT NECK Z FORCE (LB)	-2.91	485.83	-52.35	246.2	251.9
INT NECK RESULTANT (LB)	3.03	488.61	0.20	246.2	10.7
INT NECK Mx TORQUE (IN-LB)	-2.35	23.51	-20.97	138.6	246.1
INT NECK My TORQUE (IN-LB)	-2.70	155.71	-30.20	122.6	250.3
INT NECK Mz TORQUE (IN-LB)	0.23	11.41	-11.28	266.6	133.7
INT NECK TORQUE RES (IN-LB)	3.61	156.13	0.54	122.6	32.0
INT LOWER NECK X FORCE (LB)	-0.40	21.48	-235.96	244.4	82.9
INT LOWER NECK Y FORCE (LB)	-0.90	9.43	-10.77	248.0	134.0
INT LOWER NECK Z FORCE (LB)	-5.10	502.71	-115.96	246.5	113.3
INT LOWER NECK RES (LB)	5.25	502.72	1.58	246.5	446.4
INT LOWER NECK Mx (IN-LB)	-2.43	24.66	-32.60	366.7	123.2

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201302 Test: 8701 Test Date: 130204 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: D2

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT LOWER NECK My (IN-LB)	-6.27	1140.70	-136.00	128.8	245.0
INT LOWER NECK Mz (IN-LB)	0.00	13.88	-18.22	183.2	124.4
INT LOWER NECK RES (IN-LB)	6.75	1140.99	0.37	128.8	494.2
INT NECK SPRING FRONT FORCE (	1.45	10.98	-7.02	247.0	81.7
INT NECK SPRING REAR FORCE (L	-1.62	179.55	-4.39	133.3	56.6
INT OC Ry ANGLE (DEG)	88.59	98.46	87.45	202.8	286.9
INT UPPER LT THORAX DX (MM)	83.26	83.50	65.61	1.5	82.1
INT UPPER LT THORAX RY (DEG)	2.16	9.33	0.78	158.6	245.3
INT UPPER LT THORAX RZ (DEG)	8.57	9.15	7.59	96.9	267.7
INT UPPER RT THORAX DX (MM)	85.78	87.31	73.78	184.9	80.9
INT UPPER RT THORAX RY (DEG)	2.38	5.38	0.59	155.9	83.8
INT UPPER RT THORAX RZ (DEG)	-12.12	-12.04	-13.56	43.2	259.1
INT LOWER LT THORAX DX (MM)	122.64	124.70	106.12	284.2	133.8
INT LOWER LT THORAX RY (DEG)	10.82	15.76	4.44	253.4	147.1
INT LOWER LT THORAX RZ (DEG)	6.49	8.22	3.08	279.8	86.8
INT LOWER RT THORAX DX (MM)	121.94	123.16	104.15	38.8	131.0
INT LOWER RT THORAX RY (DEG)	13.20	17.60	6.61	274.4	143.4
INT LOWER RT THORAX RZ (DEG)	-9.92	-9.35	-10.91	70.7	268.2
INT LEFT CLAVICLE MFX (LB)	1.19	89.14	0.98	80.2	0.9
INT LEFT CLAVICLE MFZ FORCE (L	0.02	1.92	-56.30	258.0	81.2
INT LEFT CLAVICLE LFX FORCE (LE	-0.57	-0.35	-43.13	7.2	83.5
INT LEFT CLAVICLE LFZ FORCE (LE	-0.12	28.99	-0.75	76.4	458.6
INT STERNUM X ACCEL (G)	0.00	13.24	-22.20	246.4	70.9
INT T1 X ACCEL (G)	0.02	17.20	-19.24	248.2	72.0
INT T1 Y ACCEL (G)	0.01	2.55	-2.51	248.3	252.2
INT T1 Z ACCEL (G)	1.00	16.07	-6.47	245.6	248.6
INT T2 X ACCEL (G)	0.01	8.16	-20.06	248.2	80.1
INT T2 Y ACCEL (G)	-0.01	2.72	-2.75	249.6	104.1
INT T2 Z ACCEL (G)	0.99	11.70	-9.72	246.4	249.3
INT CHEST X ACCEL (G)	0.00	12.78	-19.58	244.2	76.8
INT CHEST Y ACCEL (G)	0.01	2.15	-1.95	247.6	100.5
INT CHEST Z ACCEL (G)	0.99	10.30	-3.41	246.7	250.0
INT CHEST RESULTANT (G)	1.00	19.96	0.12	76.9	286.9
INT THORAX SPINE X FORCE (LB)	9.13	146.34	-97.18	101.4	247.9
INT THORAX SPINE Y FORCE (LB)	-2.15	17.53	-12.87	97.5	182.7
INT THORAX SPINE Z FORCE (LB)	-15.91	66.47	-283.68	249.5	132.7
INT THORAX SPINE Mx (IN-LB)	-18.09	55.87	-124.26	247.3	99.7

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201302 Test: 8701 Test Date: 130204 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: D2

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT THORAX SPINE My (IN-LB)	-74.84	378.96	-261.92	169.0	73.8
INT RIGHT ACETABULAR X (LB)	-1.35	265.64	-8.76	86.1	253.9
INT RIGHT ACETABULAR Y (LB)	4.82	73.14	-41.68	104.8	52.2
INT RIGHT ACETABULAR Z (LB)	9.51	51.31	-6.88	76.3	339.6
INT PELVIS X ACCEL (G)	0.05	2.32	-18.27	252.4	84.6
INT PELVIS Y ACCEL (G)	-0.20	1.29	-1.54	137.5	115.1
INT PELVIS Z ACCEL (G)	1.26	12.48	-5.57	122.2	248.6
INT PELVIS RESULTANT (G)	1.28	18.70	0.19	84.6	246.2
INT LEFT ANKLE RX (DEG)	0.30	1.62	-2.65	299.2	131.2
INT LEFT ANKLE Ry (DEG)	276.13	286.62	261.58	61.6	203.1
INT LEFT ANKLE Rz (DEG)	51.25	51.31	47.85	34.9	162.9
INT RIGHT ANKLE Rx (DEG)	4.24	6.07	3.77	254.9	47.8
INT RIGHT ANKLE Ry (DEG)	2.81	13.52	2.79	86.8	1.6
INT RIGHT ANKLE Rz (DEG)	47.97	49.16	47.05	312.2	84.0

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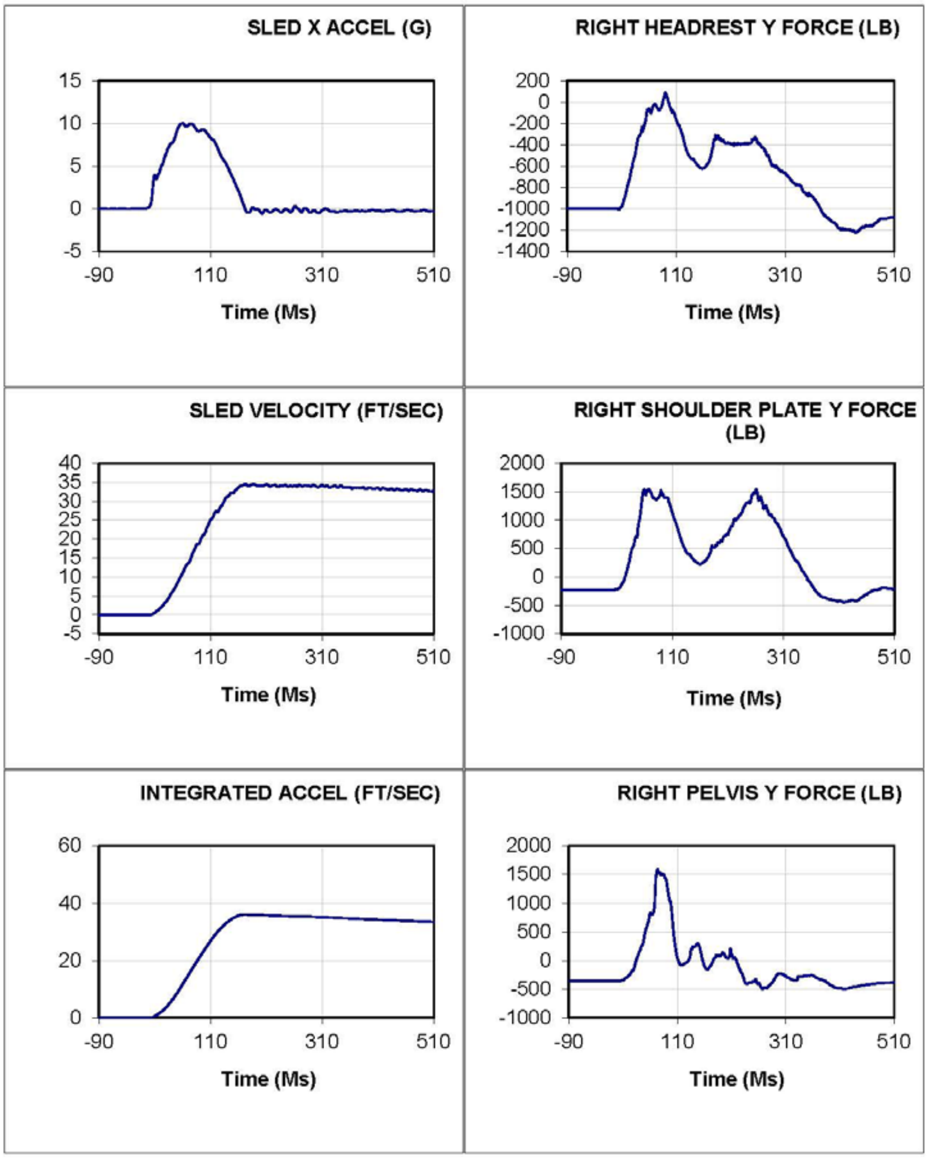
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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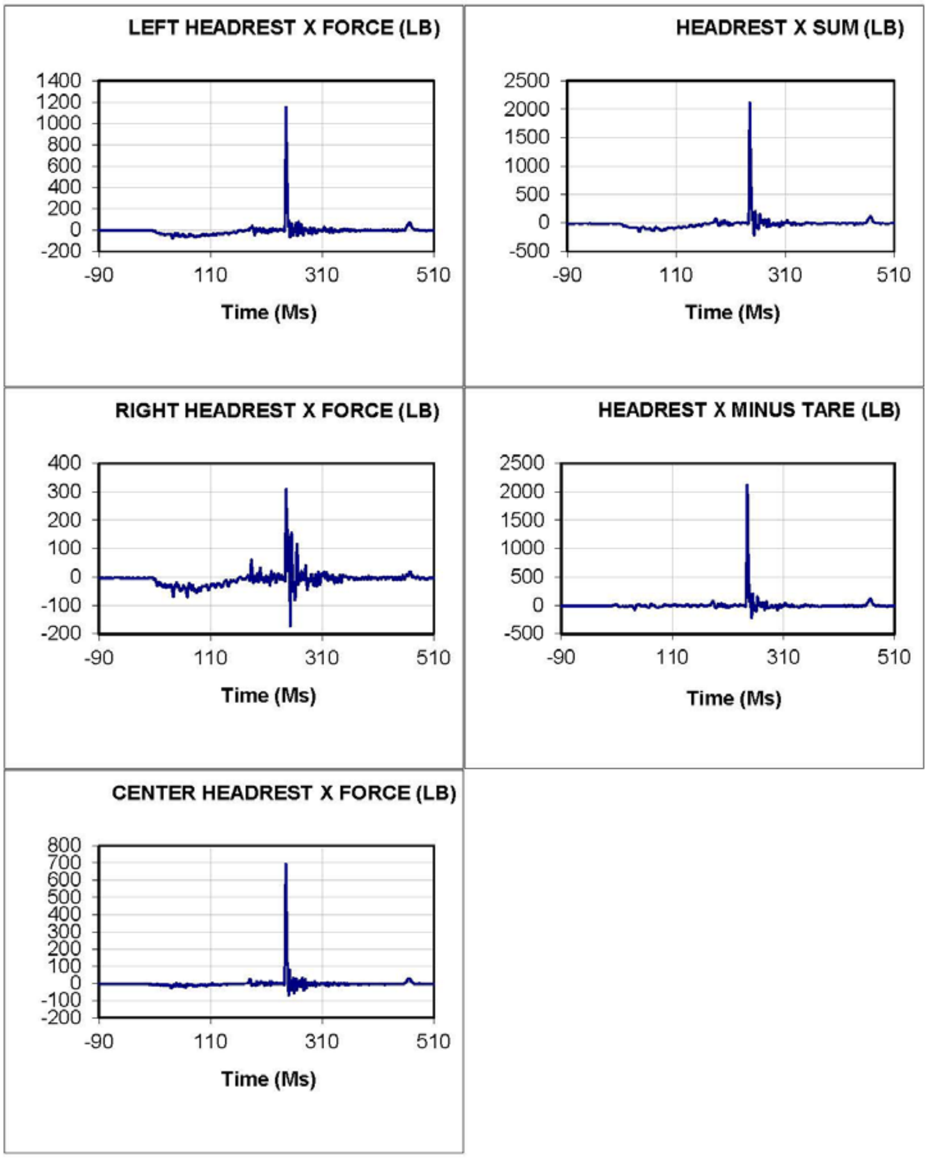
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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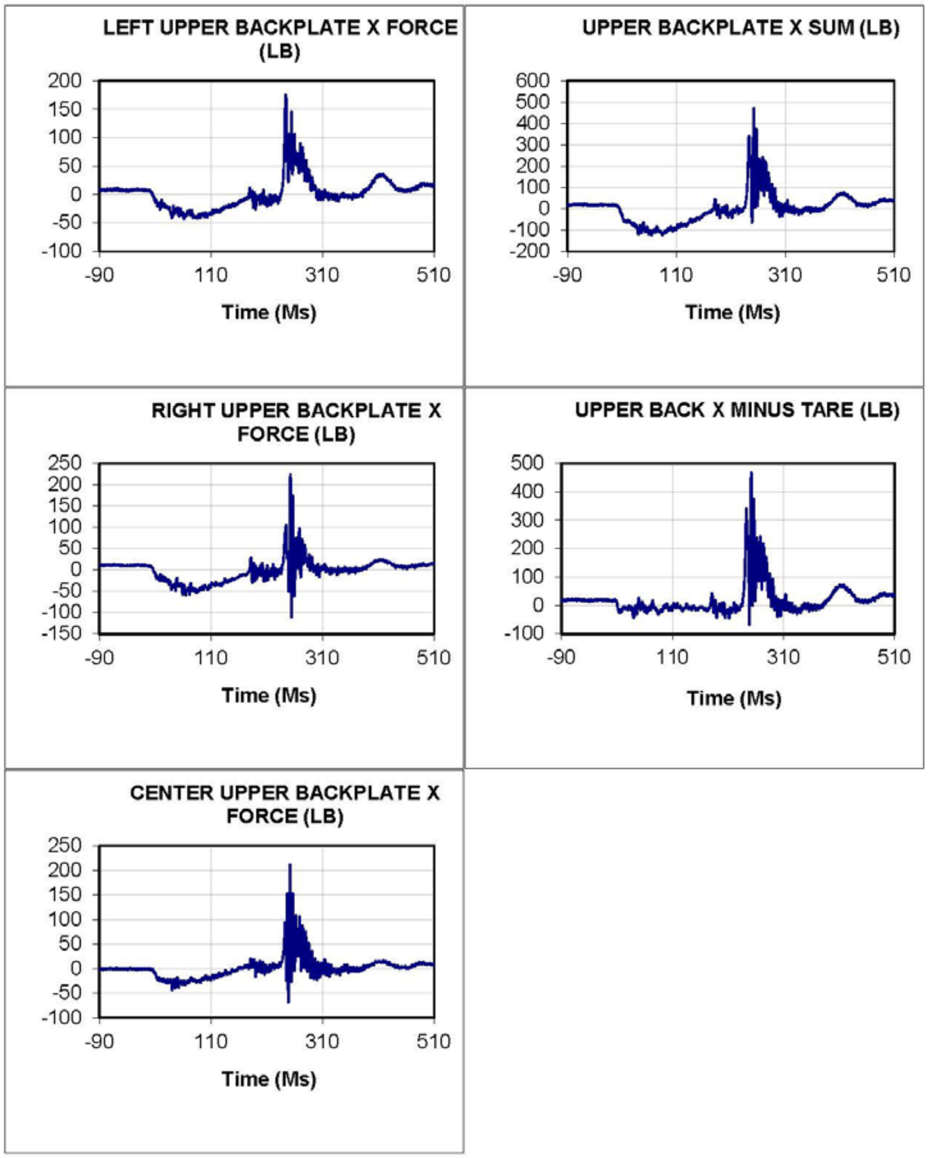
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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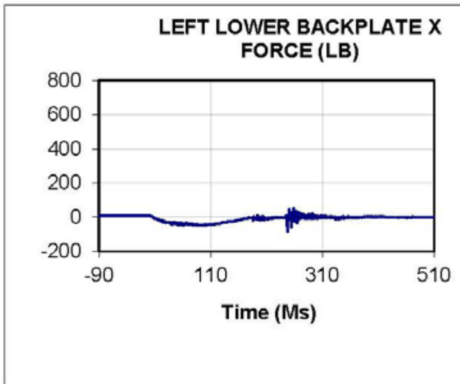
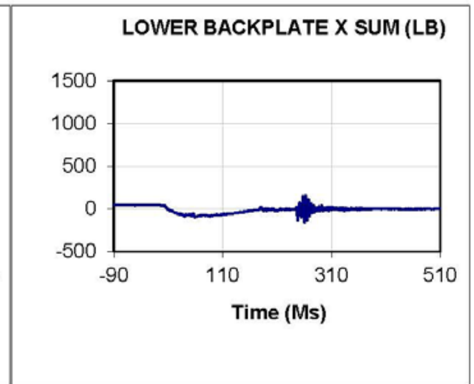
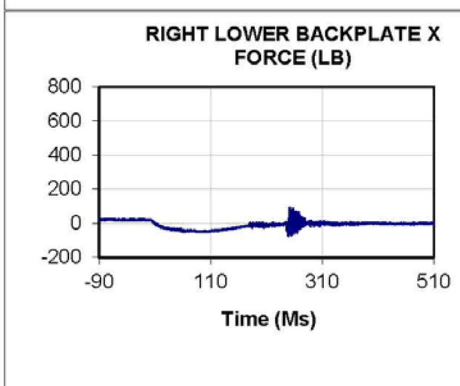
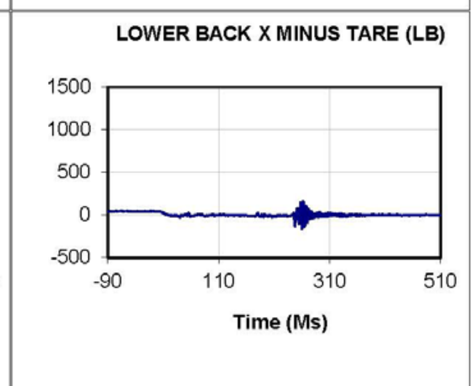
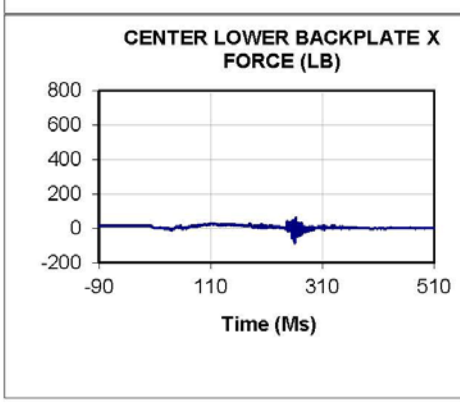

LEFT LOWER BACKPLATE X FORCE (LB)
800
600
400
200
0
-200
-90
110
310
510
Time (Ms)

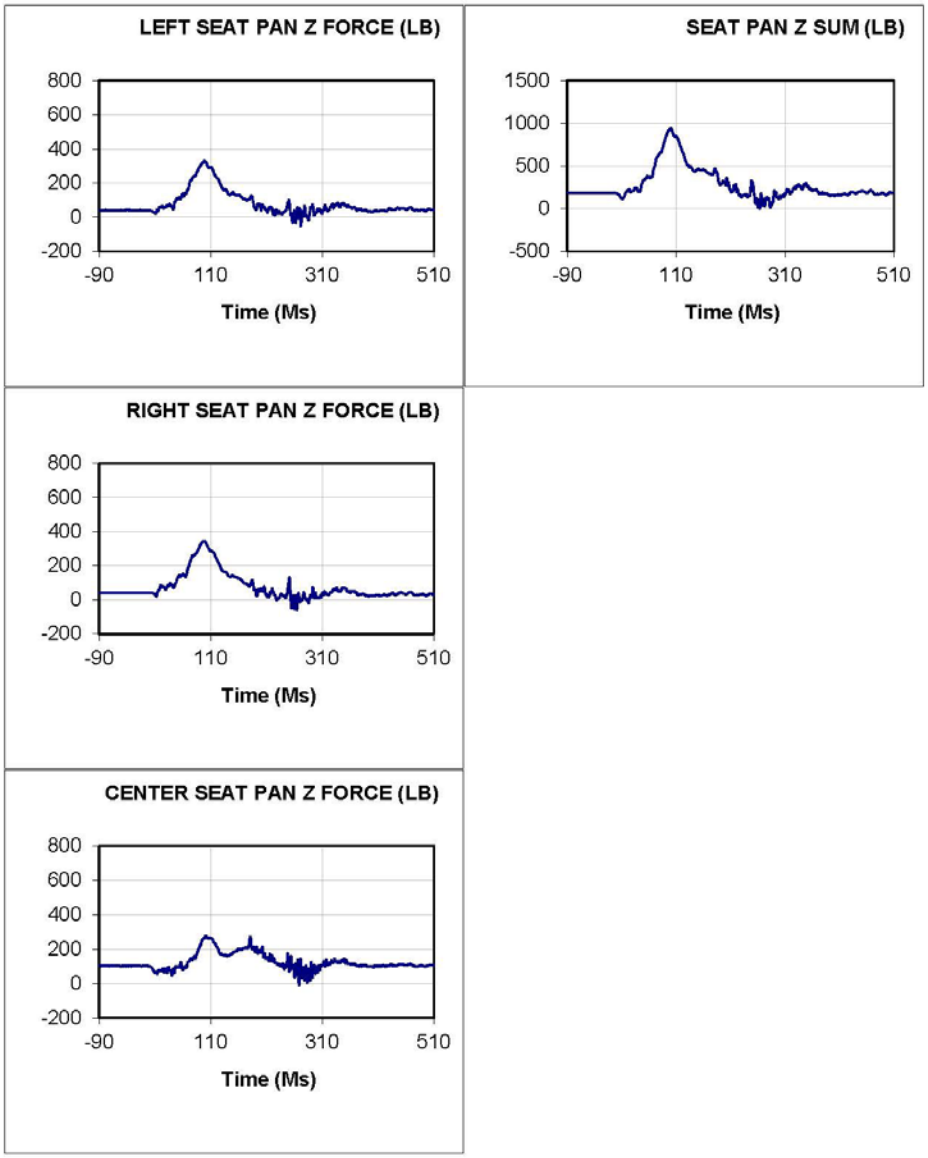

LOWER BACKPLATE X SUM (LB)
1500
1000
500
0
-500
-90
110
310
510
Time (Ms)


RIGHT LOWER BACKPLATE X FORCE (LB)
800
600
400
200
0
-200
-90
110
310
510
Time (Ms)


LOWER BACK X MINUS TARE (LB)
1500
1000
500
0
-500
-90
110
310
510
Time (Ms)


CENTER LOWER BACKPLATE X FORCE (LB)
800
600
400
200
0
-200
-90
110
310
510
Time (Ms)

201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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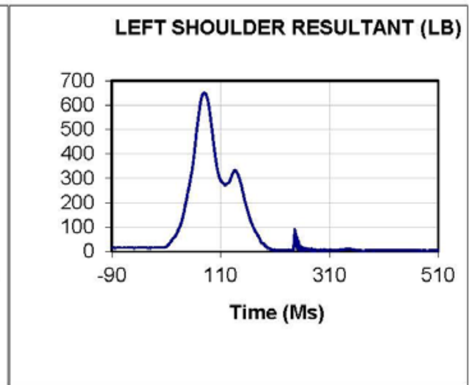
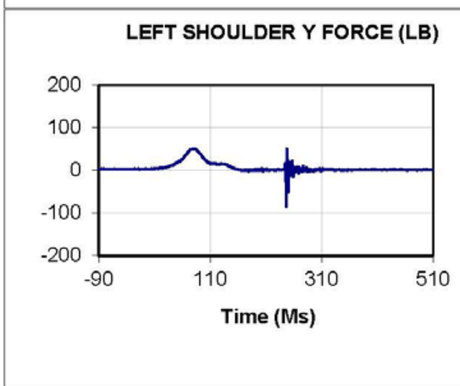
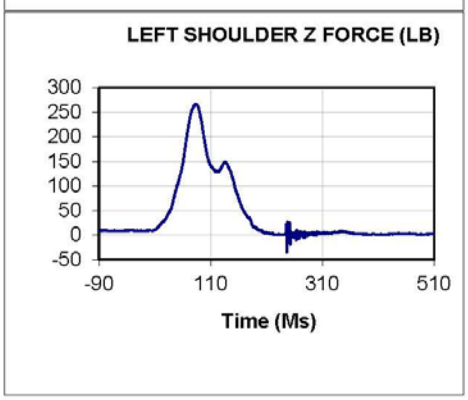
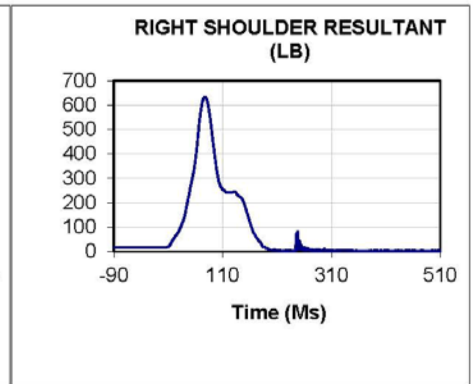
LEFT SHOULDER X FORCE (LB)
100
0
-100
-200
-300
-400
-500
-600
-700
-90
110
310
510
Time (Ms)

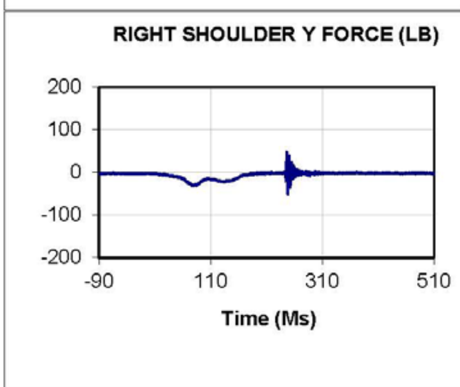

LEFT SHOULDER RESULTANT (LB)
700
600
500
400
300
200
100
0
-90
110
310
510
Time (Ms)

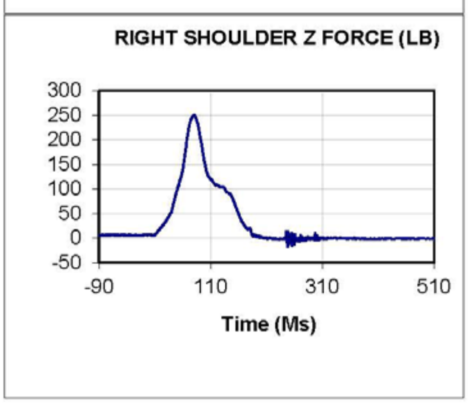

LEFT SHOULDER Y FORCE (LB)
200
100
0
-100
-200
-90
110
310
510
Time (Ms)


LEFT SHOULDER Z FORCE (LB)
300
250
200
150
100
50
0
-50
-90
110
310
510
Time (Ms)

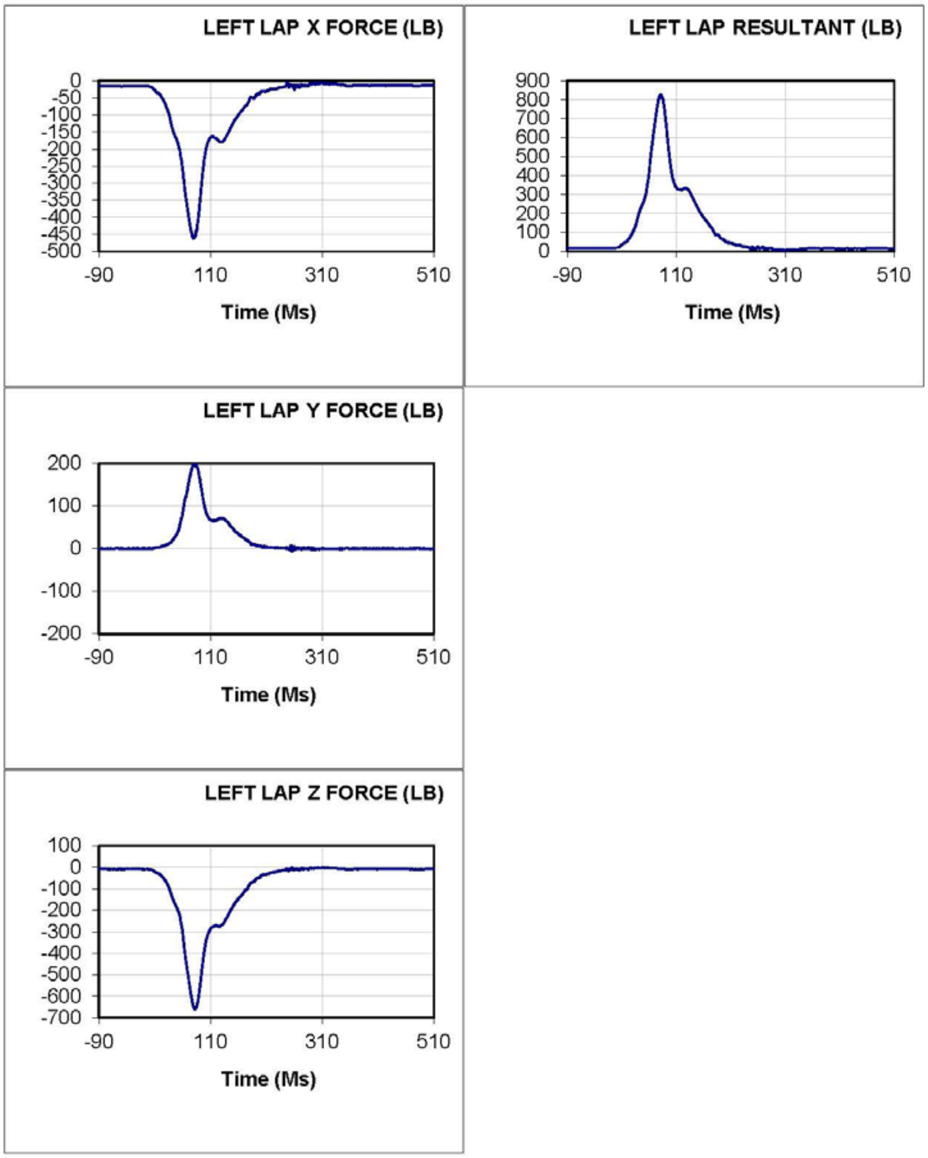

RIGHT SHOULDER X FORCE (LB)
100
0
-100
-200
-300
-400
-500
-600
-700
-90
110
310
510
Time (Ms)


RIGHT SHOULDER RESULTANT (LB)
700
600
500
400
300
200
100
0
-90
110
310
510
Time (Ms)


RIGHT SHOULDER Y FORCE (LB)
200
100
0
-100
-200
-90
110
310
510
Time (Ms)


RIGHT SHOULDER Z FORCE (LB)
300
250
200
150
100
50
0
-50
-90
110
310
510
Time (Ms)

201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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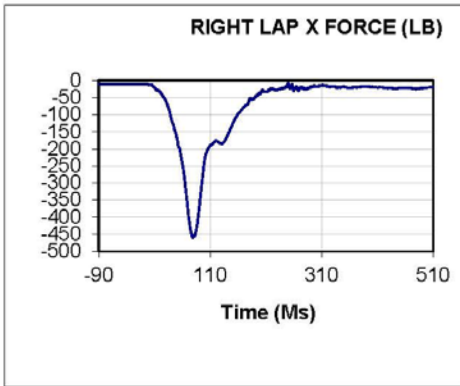
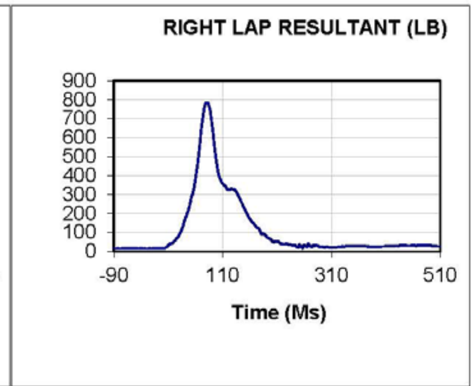
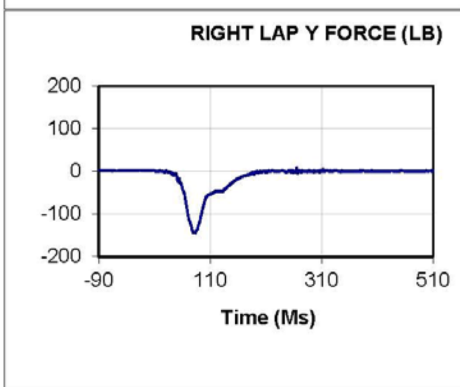
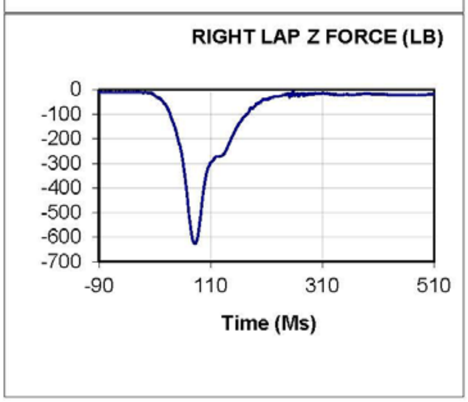
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2









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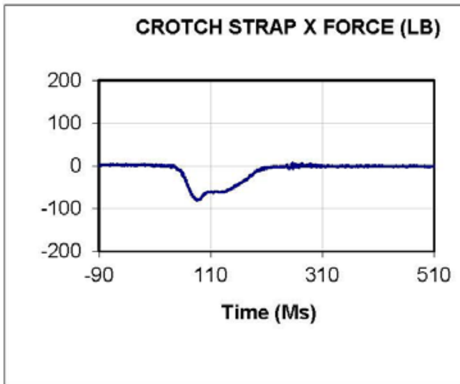
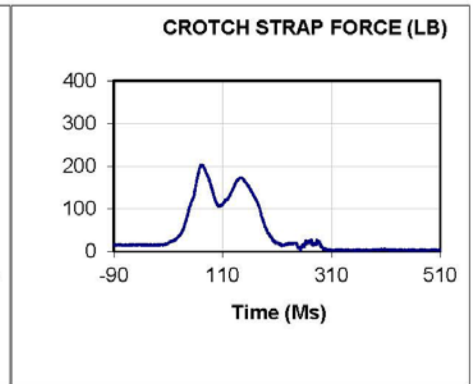
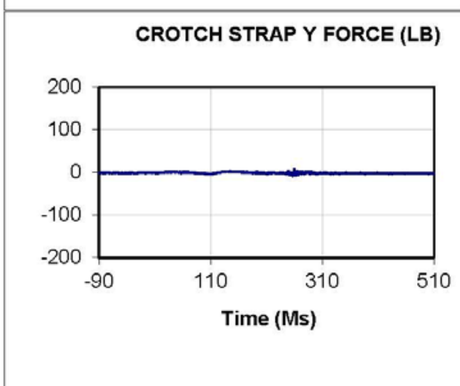
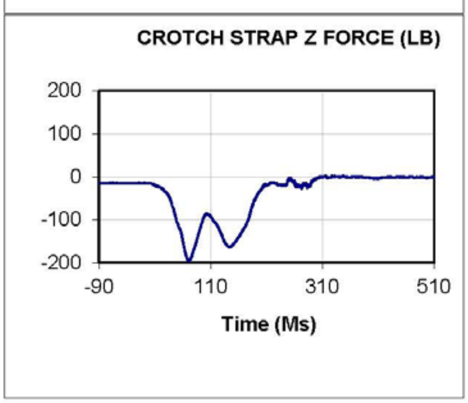
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2









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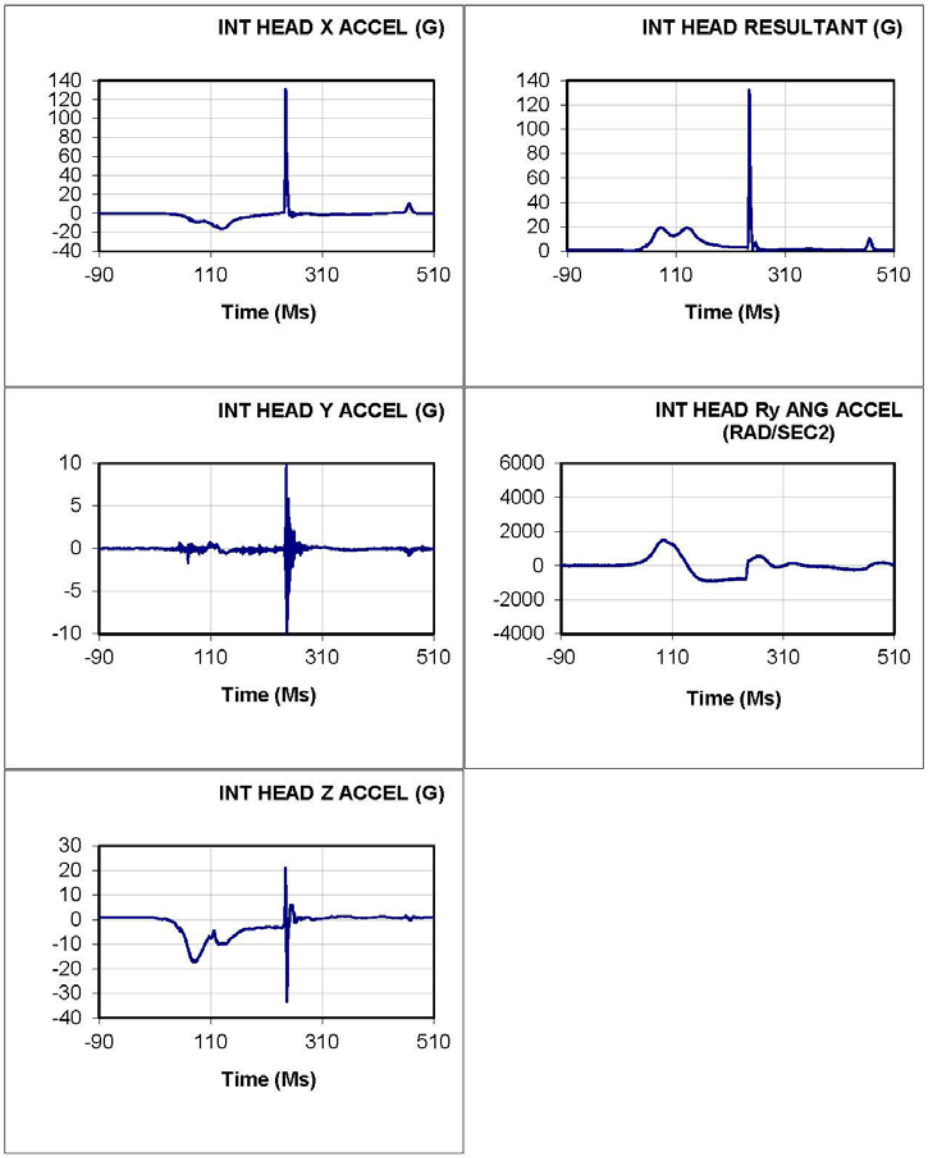
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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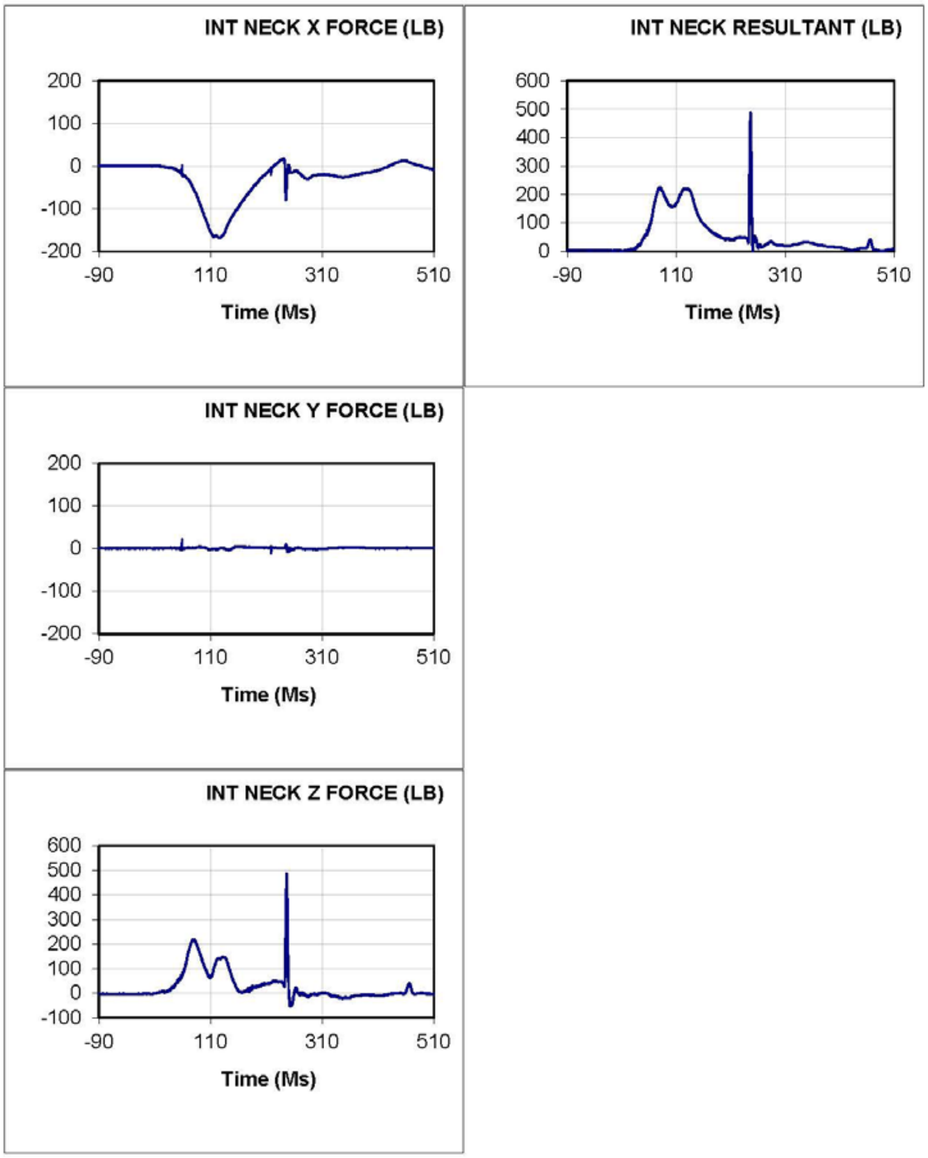
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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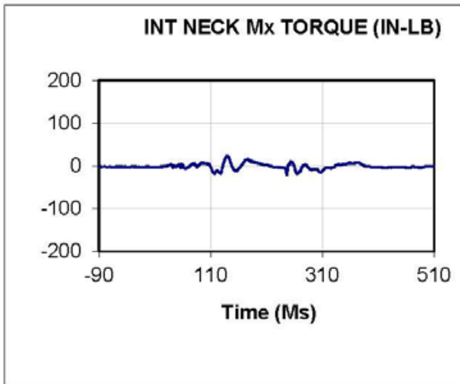
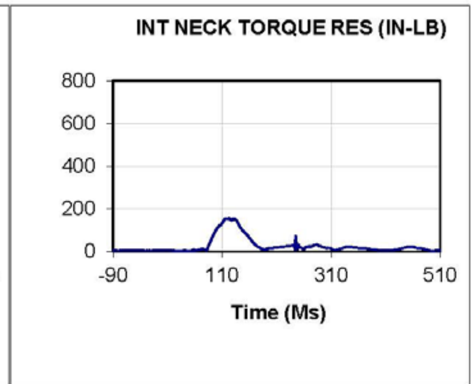
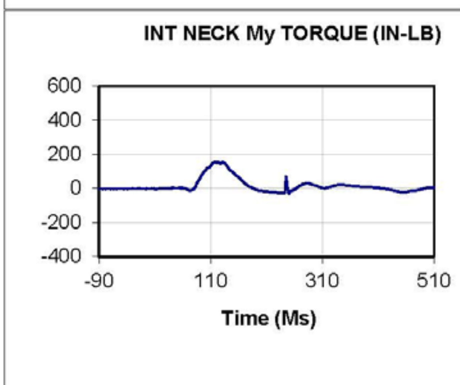
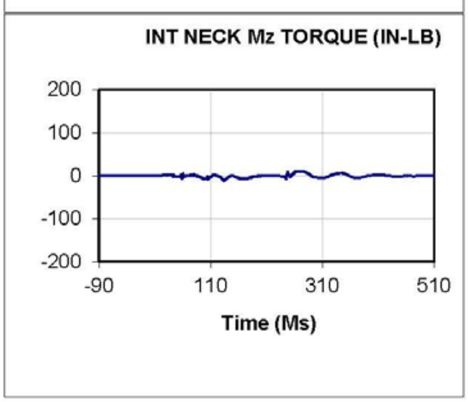
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2









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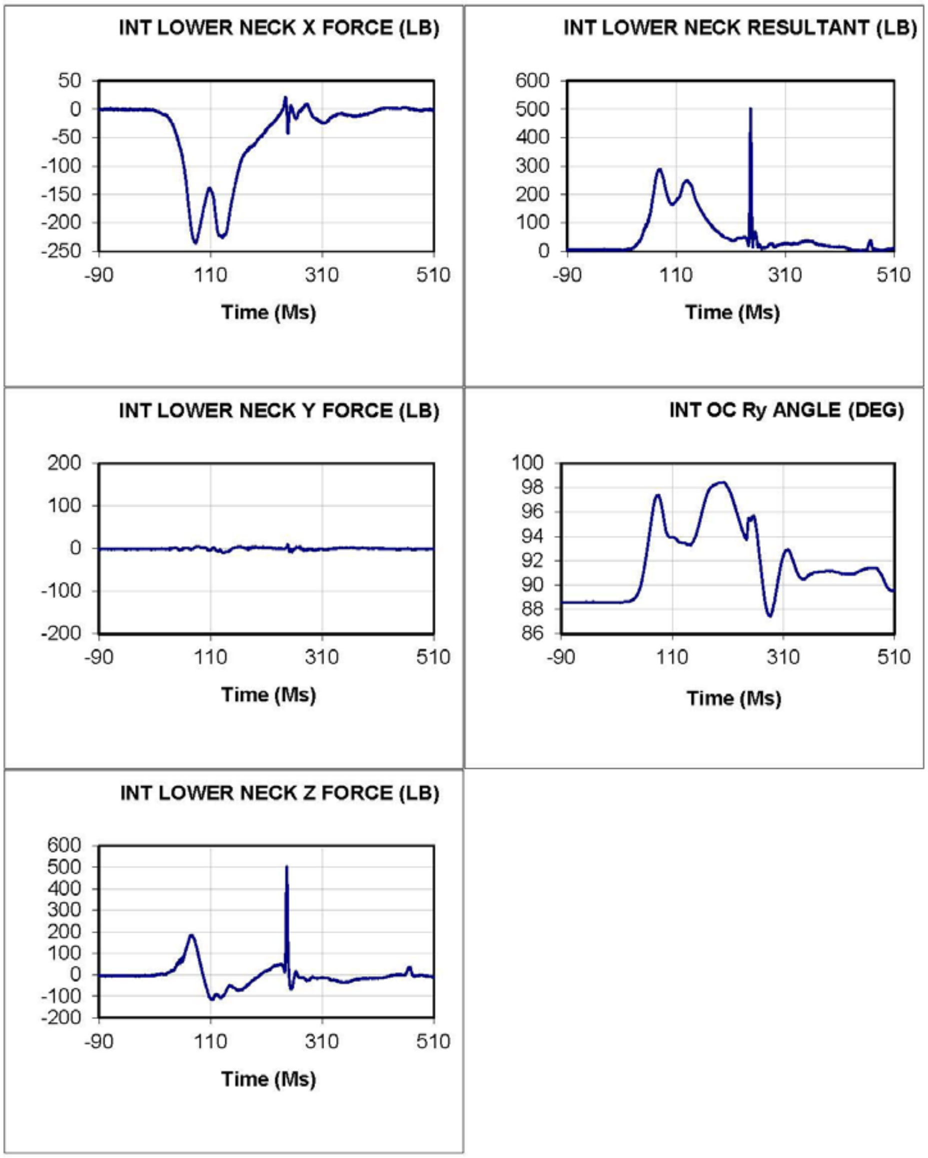
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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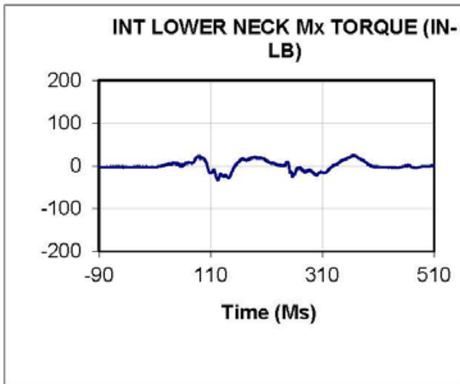
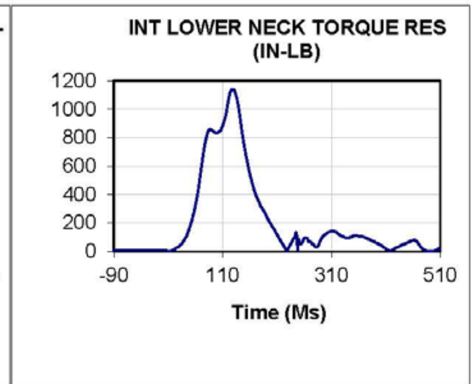
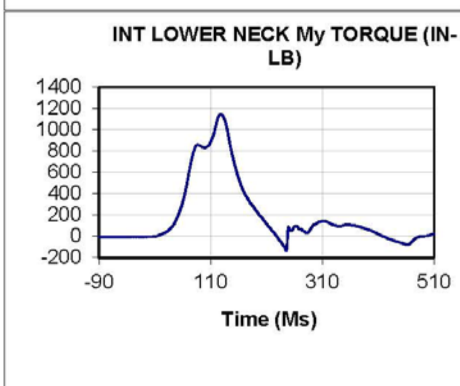
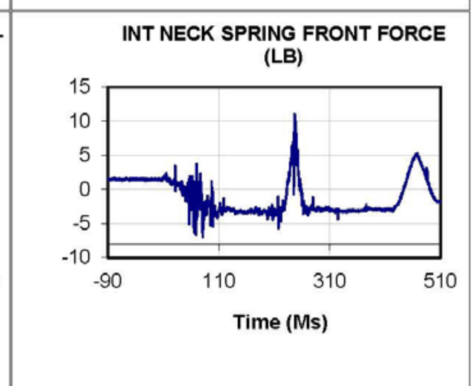
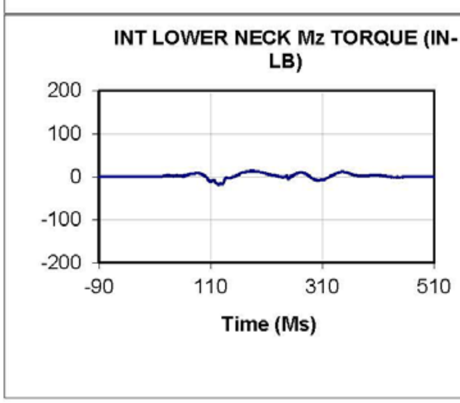
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2

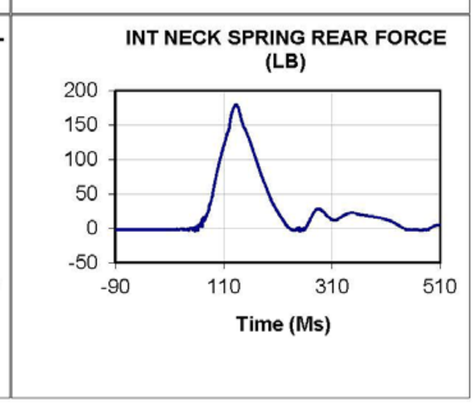




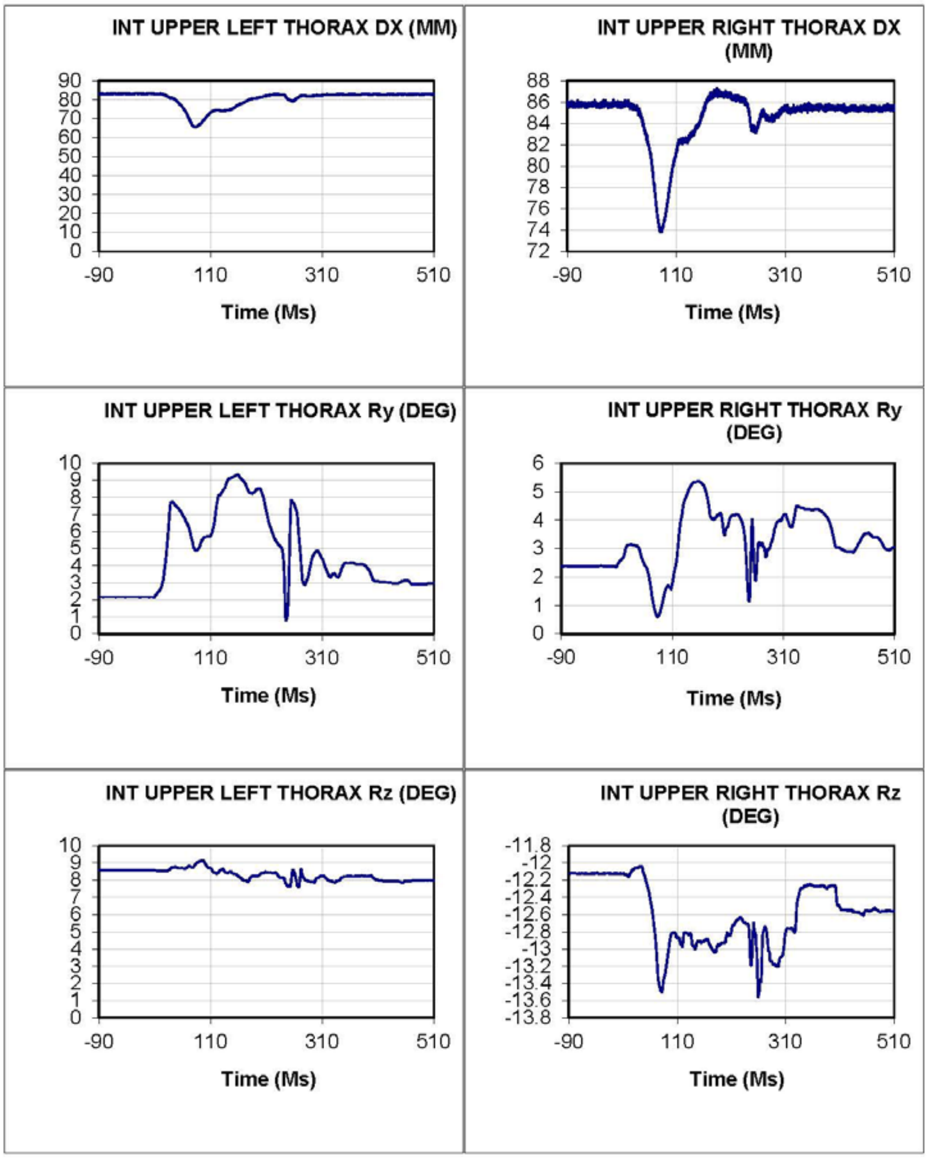








201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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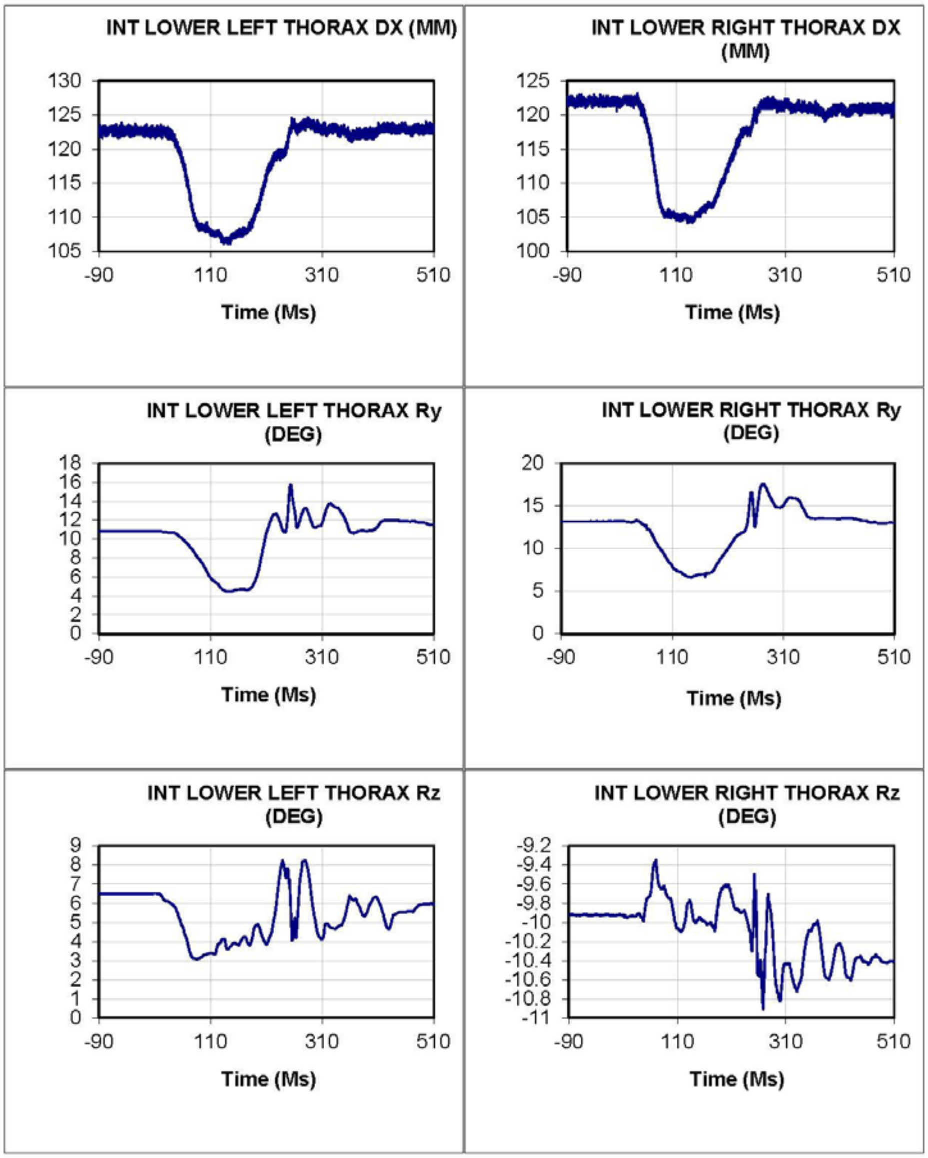
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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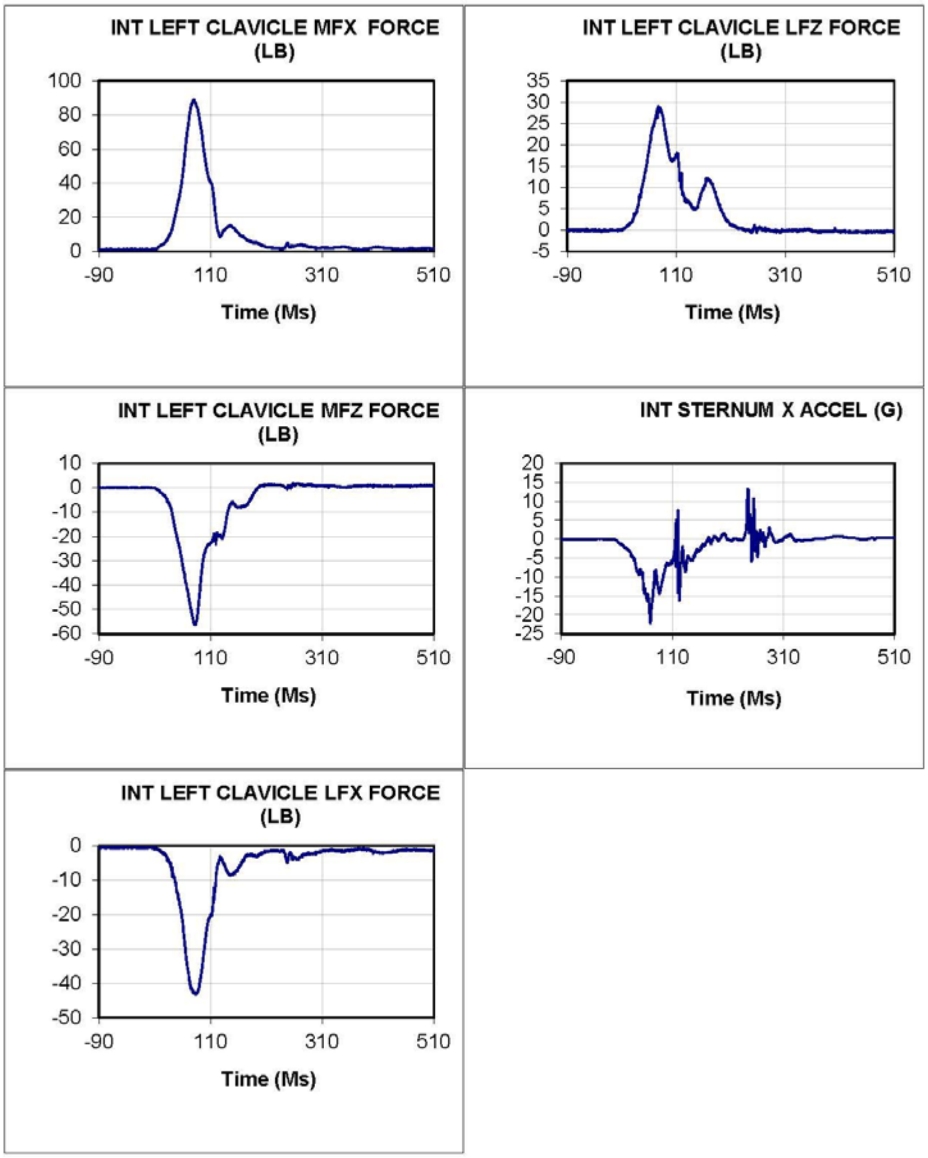
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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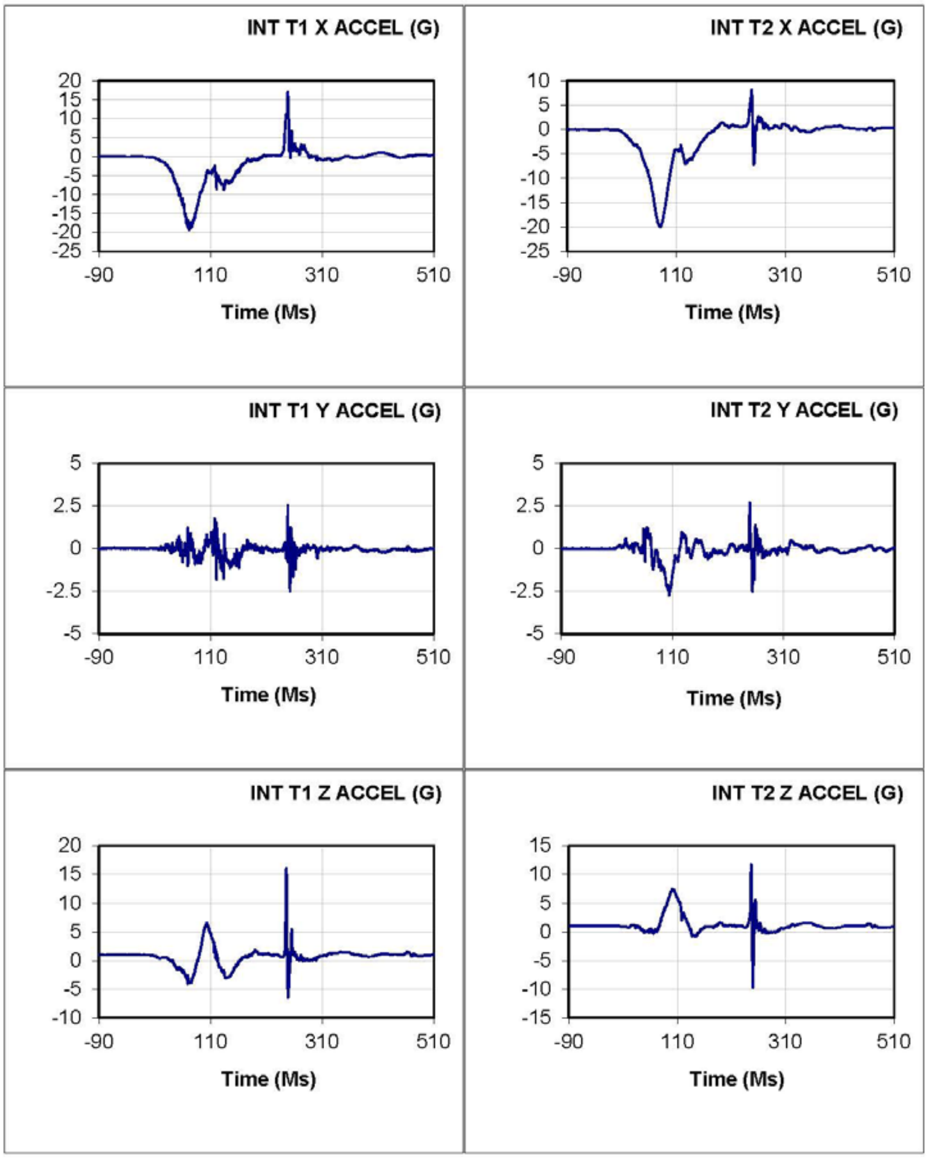
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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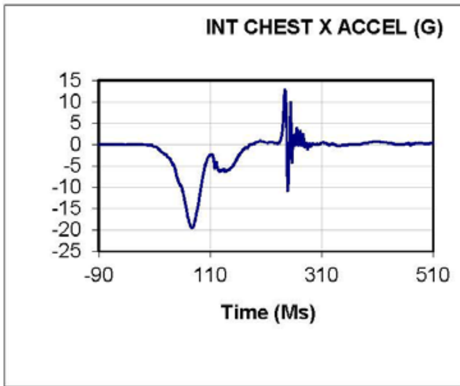
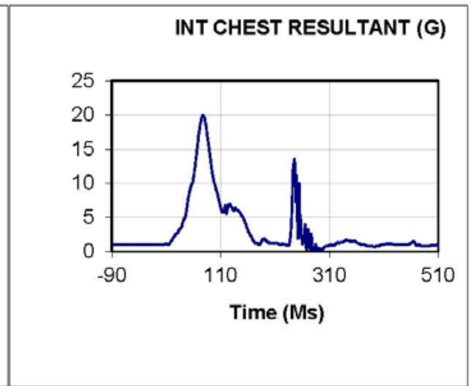
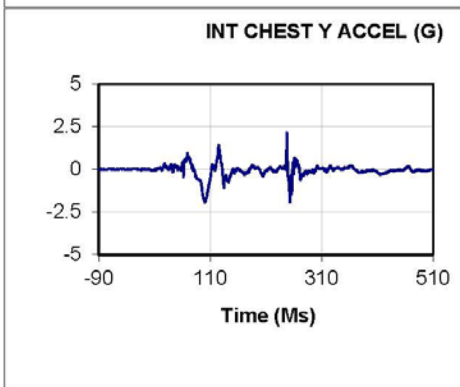
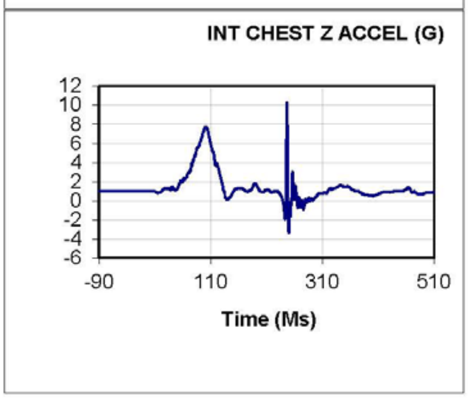
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2









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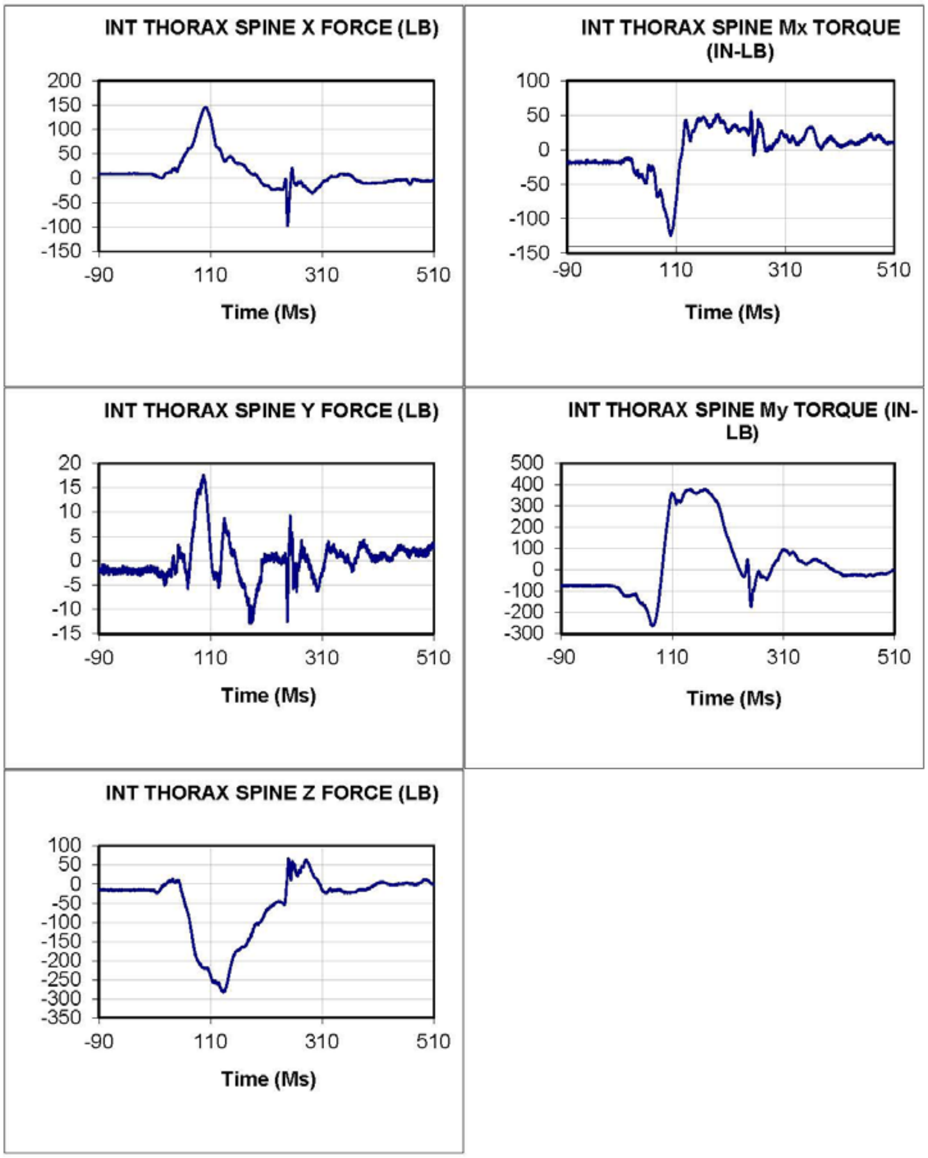
INT THORAX SPINE X FORCE (LB)
Time (Ms)
INT THORAX SPINE Mx TORQUE (IN-LB)
Time (Ms)
INT THORAX SPINE Y FORCE (LB)
Time (Ms)
INT THORAX SPINE My TORQUE (IN-LB)
Time (Ms)
INT THORAX SPINE Z FORCE (LB)
Time (Ms)

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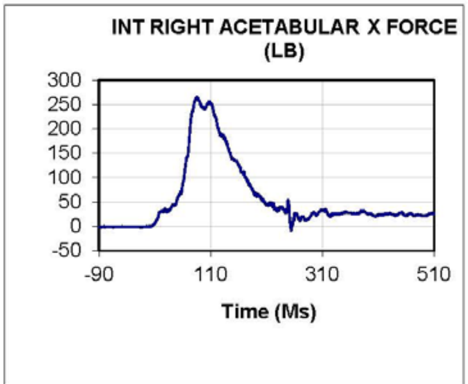
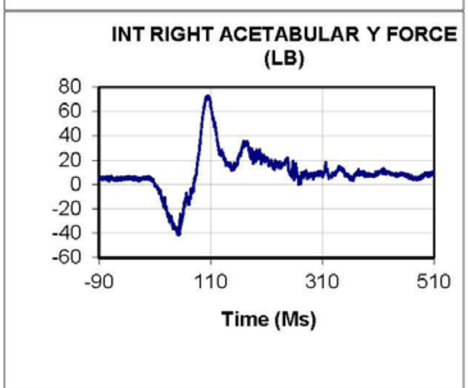
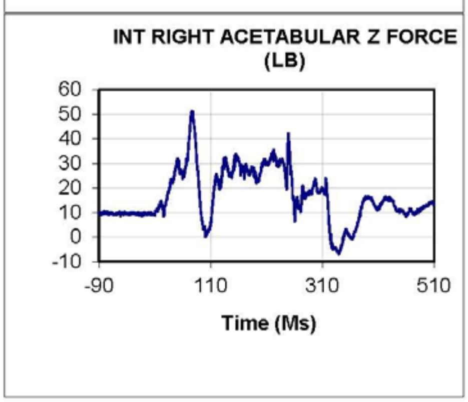
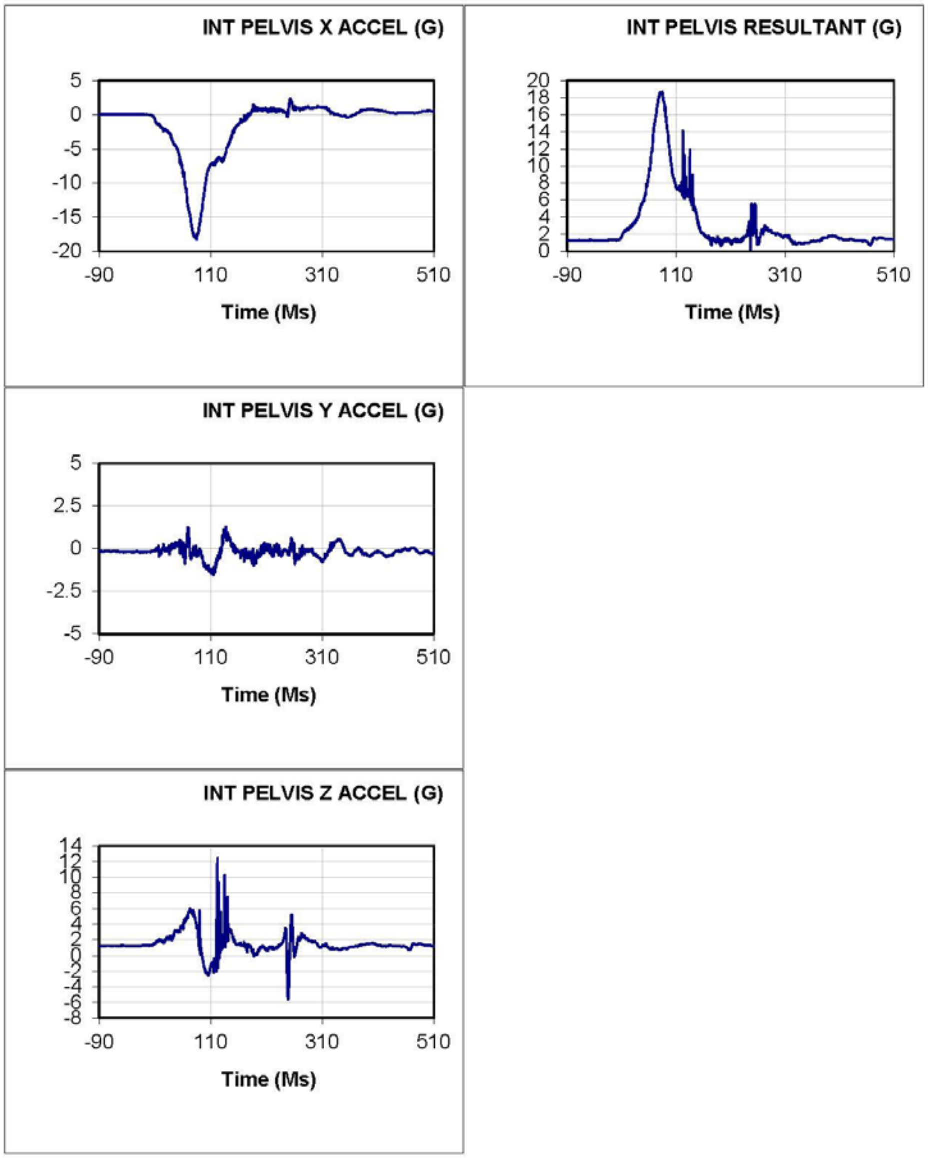
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2







201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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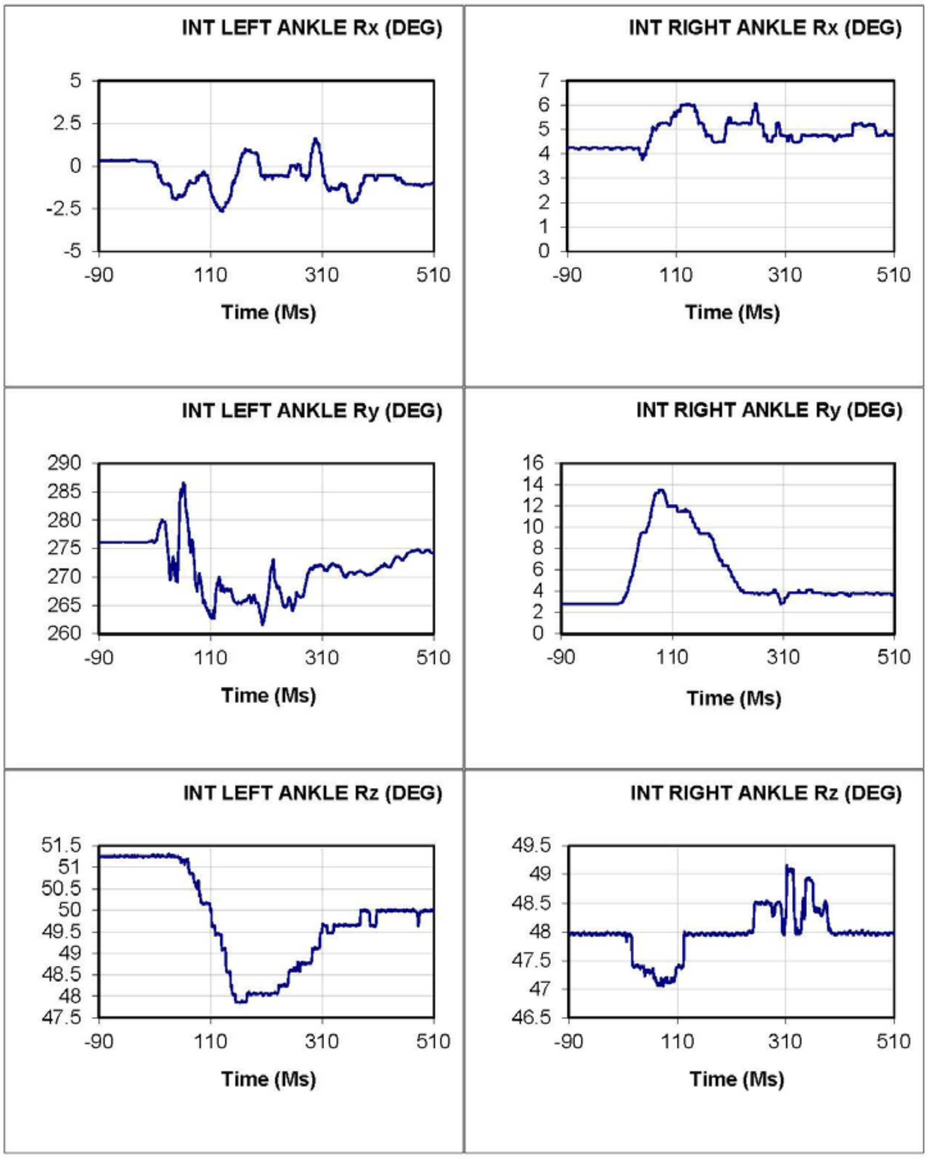
201302 Test: 8701 Test Date: 130204 Subj: THOR Cell: D2



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ATTACHMENT 5: REPRESENTATIVE DATA PRINT-OUTS (+Y-AXIS)

+Y-Axis Data Examples for THOR-K: Test 8694: Cell C2, 10 G, 70 ms time-to-peak

201302 Test: 8694 Test Date: 130131 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: C2

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
Reference Mark Time (Ms)				4.3	
Impact Rise Time (Ms)				75.1	
Impact Duration (Ms)				170.3	
Velocity Change (Ft/Sec)		35.80			
SLED X ACCEL (G)	0.02	10.05	-0.65	75.1	203.7
INTEGRATED ACCEL (FT/SEC)	0.00	35.80	0.02	170.2	0.0
LEFT HEADREST X FORCE (LB)	-6.22	38.74	-52.76	202.6	42.6
RIGHT HEADREST X FORCE (LB)	-4.12	36.17	-41.79	69.9	184.2
CT HEADREST X FORCE (LB)	-4.11	22.50	-22.49	76.6	186.9
HEADREST X SUM (LB)	-14.45	46.77	-78.07	216.5	184.2
LF UPPER BACK X FORCE (LB)	9.12	44.35	-14.29	334.5	203.5
RT UPPER BACK X FORCE (LB)	7.37	159.21	-17.05	75.5	202.0
CT UPPER BACK X FORCE (LB)	-5.40	27.82	-31.02	76.4	192.2
UPPER BACKPLATE X SUM (LB)	11.09	224.85	-34.97	76.4	208.3
LF LOWER BACK X FORCE (LB)	16.40	45.19	-7.26	183.4	93.6
RT LOWER BACK X FORCE (LB)	-0.53	66.55	-16.57	72.6	234.1
CT LOWER BACK X FORCE (LB)	9.77	52.41	-0.61	79.7	252.7
LOWER BACKPLATE X SUM (LB)	25.65	127.98	2.12	74.5	234.4
LEFT SEAT PAN Z FORCE (LB)	44.90	94.44	-47.65	188.9	69.4
RIGHT SEAT PAN Z FORCE (LB)	37.68	237.69	2.75	90.7	259.1
CENTER SEAT PAN Z FORCE (LB)	101.38	269.97	75.14	81.8	241.5
SEAT PAN Z SUM (LB)	183.95	523.53	119.01	81.5	251.6
LEFT SHOULDER X FORCE (LB)	-7.54	-3.13	-48.91	181.1	318.1
LEFT SHOULDER Y FORCE (LB)	2.32	24.82	-28.64	49.9	336.4
LEFT SHOULDER Z FORCE (LB)	7.37	44.60	6.39	343.6	186.6
LEFT SHOULDER RES (LB)	10.82	70.52	8.98	338.4	179.9
RIGHT SHOULDER X FORCE (LB)	-12.42	-3.54	-40.27	487.3	84.9
RIGHT SHOULDER Y FORCE (LB)	-3.67	13.33	-12.07	50.3	353.4
RIGHT SHOULDER Z FORCE (LB)	3.39	16.96	-1.50	88.7	492.4
RIGHT SHOULDER RES (LB)	13.41	44.26	4.36	84.9	467.9
LEFT LAP X FORCE (LB)	-12.21	-6.21	-71.07	198.8	68.6
LEFT LAP Y FORCE (LB)	-0.09	90.01	-2.74	60.6	296.1
LEFT LAP Z FORCE (LB)	-4.81	0.38	-70.86	199.8	58.1
LEFT LAP RESULTANT (LB)	13.14	130.66	6.41	60.6	198.7

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201302 Test: 8694 Test Date: 130131 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: C2

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
RIGHT LAP X FORCE (LB)	-10.07	-1.11	-40.29	25.2	311.0
RIGHT LAP Y FORCE (LB)	3.00	52.66	2.47	74.0	2.0
RIGHT LAP Z FORCE (LB)	-19.95	-8.13	-44.73	26.8	260.7
RIGHT LAP RESULTANT (LB)	22.57	67.64	11.30	73.1	25.2
CROTCH STRAP X FORCE (LB)	-2.28	8.22	-4.42	81.3	188.8
CROTCH STRAP Y FORCE (LB)	-2.46	60.98	-6.60	83.8	218.4
CROTCH STRAP Z FORCE (LB)	-14.84	1.93	-74.59	201.0	57.6
CROTCH STRAP FORCE (LB)	15.23	91.40	1.36	75.9	180.7
RIGHT HEADREST Y FORCE (LB)	-2.12	316.26	-11.82	47.4	183.1
RT SHOULDER PLATE Y (LB)	-2.84	1092.14	-16.23	51.3	211.3
RIGHT PELVIS PLATE Y FORCE (LB	-5.65	1115.43	-42.41	57.6	279.4
RIGHT KNEE PLATE Y FORCE (LB)	13.77	792.68	-9.40	88.9	276.3
RT HEADREST Y MINUS TARE (LB)	-2.16	296.15	-12.14	47.4	183.1
RT SHOULDER Y MINUS TARE (LB)	-2.88	1070.85	-15.73	51.3	211.3
RT PELVIS Y MINUS TARE (LB)	-5.67	1101.73	-42.27	57.6	279.4
RT KNEE Y MINUS TARE (LB)	13.70	756.76	-9.02	88.9	276.3
INT HEAD X ACCEL (G)	0.00	3.21	-1.92	66.9	91.4
INT HEAD Y ACCEL (G)	-0.02	14.20	-1.85	45.7	359.8
INT HEAD Z ACCEL (G)	1.00	4.65	-0.86	66.2	25.2
INT HEAD RESULTANT (G)	1.00	14.50	0.61	45.7	259.3
INT HEAD HIC		6.27		59.9	74.9
INT HEAD Rx ANG (RAD/SEC2)	0.33	152.51	-414.61	190.4	34.8
INT HEAD Ry ANG (RAD/SEC2)	0.09	115.30	-83.63	79.2	114.6
INT HEAD Rz ANG (RAD/SEC2)	1.33	134.46	-163.24	54.3	93.8
INT NECK X FORCE (LB)	-3.87	0.64	-15.70	128.5	93.9
INT NECK Y FORCE (LB)	-0.90	82.11	-11.33	48.2	223.1
INT NECK Z FORCE (LB)	-4.41	104.04	-61.37	71.2	47.4
INT NECK RESULTANT (LB)	5.97	104.09	0.46	71.2	182.6
INT NECK Mx TORQUE (IN-LB)	-4.33	99.39	-39.77	91.4	230.0
INT NECK My TORQUE (IN-LB)	-1.53	10.83	-11.96	84.1	125.7
INT NECK Mz TORQUE (IN-LB)	-1.13	23.68	-33.72	314.2	95.5
INT NECK TORQUE RES (IN-LB)	4.75	102.99	2.81	91.4	11.4
INT LOWER NECK X FORCE (LB)	-3.94	13.64	-13.97	50.2	65.3
INT LOWER NECK Y FORCE (LB)	-2.64	20.14	-41.77	31.9	92.7
INT LOWER NECK Z FORCE (LB)	-5.40	85.16	-70.17	70.5	50.0
INT LOWER NECK RES (LB)	7.23	92.77	2.37	70.5	176.3

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201302 Test: 8694 Test Date: 130131 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: C2

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT LOWER NECK Mx (IN-LB)	-8.68	257.42	-97.44	49.3	224.1
INT LOWER NECK My (IN-LB)	11.85	64.44	-28.02	358.6	51.9
INT LOWER NECK Mz (IN-LB)	-1.69	42.17	-21.32	316.7	95.4
INT LOWER NECK RES (IN-LB)	14.80	258.99	2.30	49.3	181.9
INT NECK SPRING FRONT FORCE (	-2.03	5.14	-9.95	59.9	57.7
INT NECK SPRING REAR FORCE (L	0.51	13.41	-9.32	77.6	73.1
INT OC Ry ANGLE (DEG)	88.74	88.86	87.67	440.9	88.7
INT UPPER LT THORAX DX (MM)	83.31	84.51	82.58	239.9	357.5
INT UPPER LT THORAX RY (DEG)	2.99	5.83	-0.90	51.6	83.2
INT UPPER LT THORAX RZ (DEG)	7.43	10.64	7.25	57.9	253.2
INT UPPER RT THORAX DX (MM)	85.98	87.97	85.00	239.9	353.1
INT UPPER RT THORAX RY (DEG)	2.38	3.14	0.67	55.9	90.3
INT UPPER RT THORAX RZ (DEG)	-12.97	-9.92	-13.26	55.8	189.6
INT LOWER LT THORAX DX (MM)	122.73	126.42	120.41	239.9	391.5
INT LOWER LT THORAX RY (DEG)	10.79	15.67	10.10	94.5	466.4
INT LOWER LT THORAX RZ (DEG)	5.99	11.59	3.54	82.0	306.6
INT LOWER RT THORAX DX (MM)	121.90	125.94	120.88	132.4	247.6
INT LOWER RT THORAX RY (DEG)	13.56	14.11	11.87	48.3	57.6
INT LOWER RT THORAX RZ (DEG)	-10.81	-9.51	-12.86	48.2	72.2
INT LEFT CLAVICLE MFX (LB)	2.85	11.56	-5.69	315.7	49.1
INT LEFT CLAVICLE MFZ FORCE (L	0.47	1.17	-9.90	179.7	56.1
INT LEFT CLAVICLE LFX FORCE (LB	-1.89	3.43	-9.08	64.2	317.9
INT LEFT CLAVICLE LFZ FORCE (LB	-0.29	7.96	-0.91	54.1	184.2
INT STERNUM X ACCEL (G)	0.00	6.66	-2.03	52.4	58.5
INT T1 X ACCEL (G)	-0.02	4.23	-2.47	69.3	52.6
INT T1 Y ACCEL (G)	0.01	22.24	-1.37	52.0	327.7
INT T1 Z ACCEL (G)	1.00	3.72	-1.58	91.1	57.5
INT T2 X ACCEL (G)	0.00	3.95	-3.24	60.8	97.6
INT T2 Y ACCEL (G)	0.01	16.60	-1.34	66.8	198.4
INT T2 Z ACCEL (G)	1.00	4.50	-0.79	91.9	57.5
INT CHEST X ACCEL (G)	0.00	2.87	-1.58	65.9	51.9
INT CHEST Y ACCEL (G)	0.02	19.63	-1.12	51.9	303.7
INT CHEST Z ACCEL (G)	1.00	3.59	-1.23	92.7	57.8
INT CHEST RESULTANT (G)	1.00	19.70	0.77	51.9	224.1
INT THORAX SPINE X FORCE (LB)	11.97	64.85	-2.58	81.5	231.6
INT THORAX SPINE Y FORCE (LB)	-8.36	36.67	-46.66	64.9	46.2
INT THORAX SPINE Z FORCE (LB)	39.74	80.32	4.58	117.1	62.3

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201302 Test: 8694 Test Date: 130131 Subj: THOR Wt: 174.0
Nom G: 10.0 Cell: C2

Data ID	Immediate Preimpact	Maximum Value	Minimum Value	Time Of Maximum	Time Of Minimum
INT THORAX SPINE Mx (IN-LB)	-55.43	339.50	-116.90	77.8	198.8
INT THORAX SPINE My (IN-LB)	44.96	185.06	41.54	87.1	8.6
INT RIGHT ACETABULAR X (LB)	-11.42	256.14	-24.64	83.5	34.3
INT RIGHT ACETABULAR Y (LB)	-13.45	33.74	-480.37	200.5	56.1
INT RIGHT ACETABULAR Z (LB)	-0.86	53.89	-22.37	59.4	48.9
INT PELVIS X ACCEL (G)	0.13	7.11	-3.64	56.4	90.6
INT PELVIS Y ACCEL (G)	-0.17	18.00	-1.36	69.1	287.1
INT PELVIS Z ACCEL (G)	1.34	4.25	-2.64	54.5	86.3
INT PELVIS RESULTANT (G)	1.35	19.22	0.54	56.5	191.8
INT LEFT ANKLE RX (DEG)	-0.56	3.89	-9.55	44.0	257.2
INT LEFT ANKLE Ry (DEG)	159.22	186.22	115.54	206.8	101.0
INT LEFT ANKLE Rz (DEG)	51.26	59.91	51.22	214.2	27.0
INT RIGHT ANKLE Rx (DEG)	1.22	19.55	-13.24	49.3	110.1
INT RIGHT ANKLE Ry (DEG)	2.75	7.37	-7.45	70.0	130.4
INT RIGHT ANKLE Rz (DEG)	47.46	54.70	47.44	191.3	2.8

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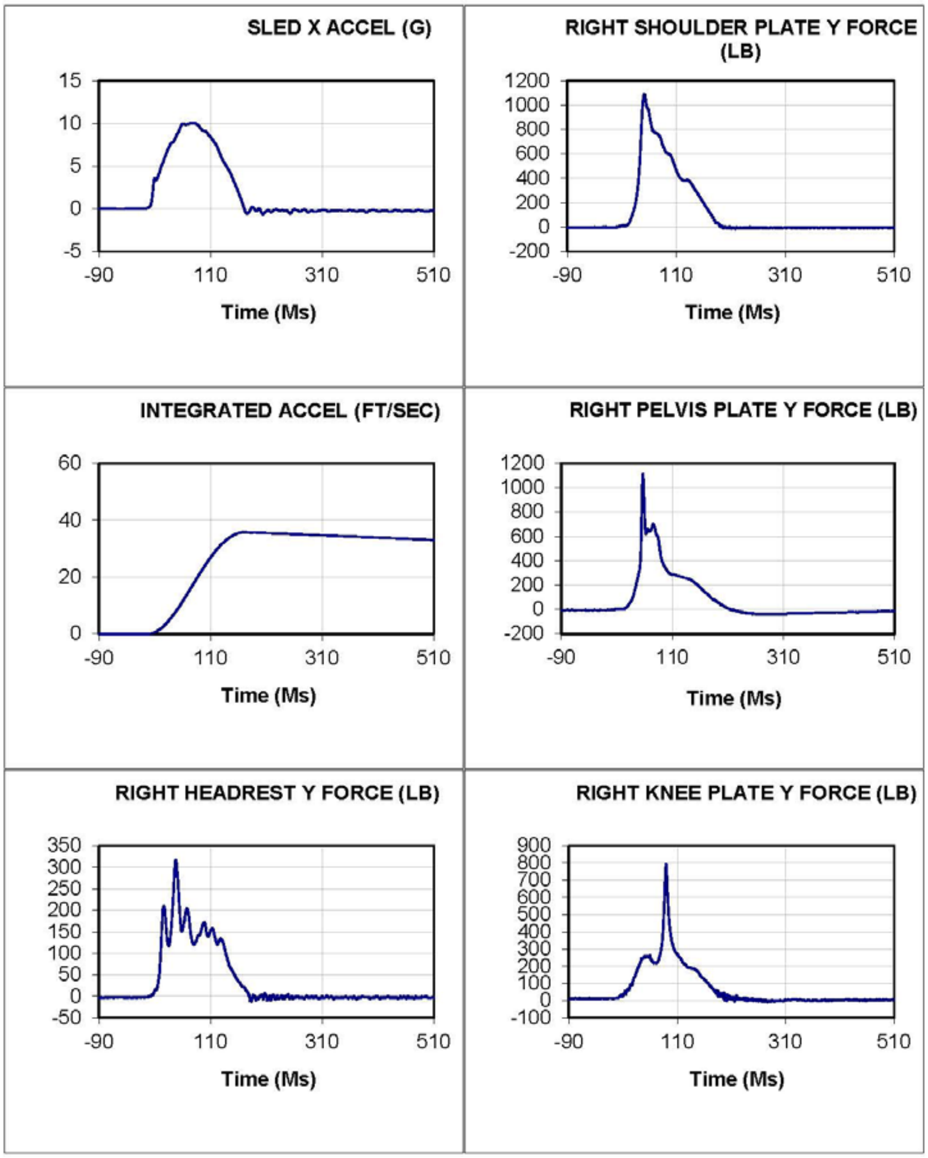
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2



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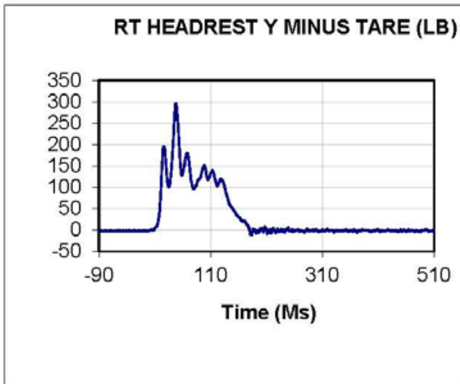
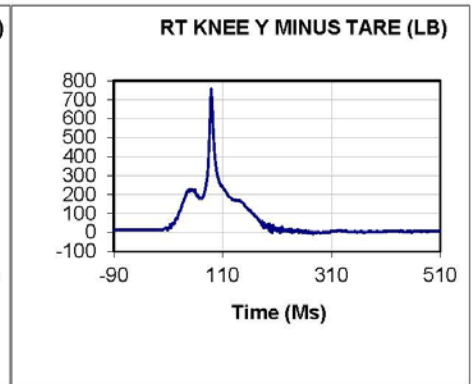
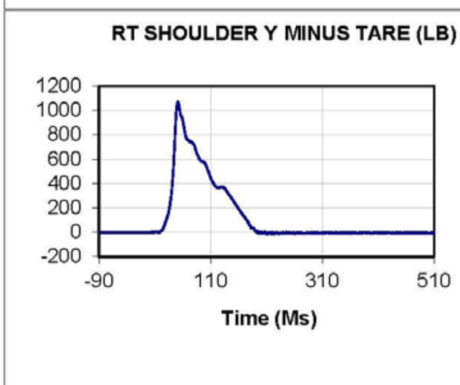
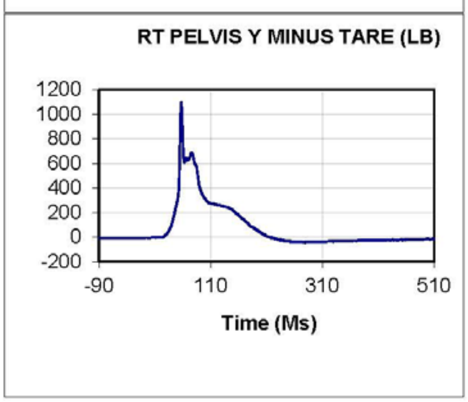
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2









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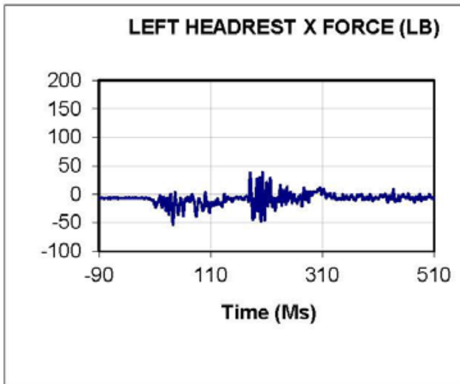
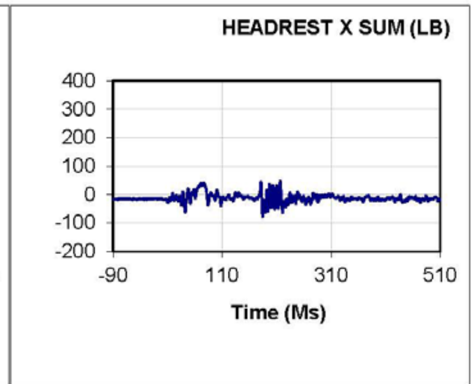
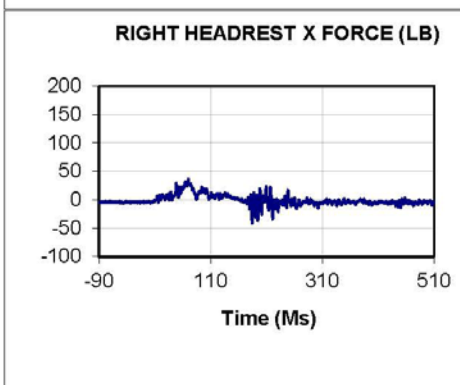
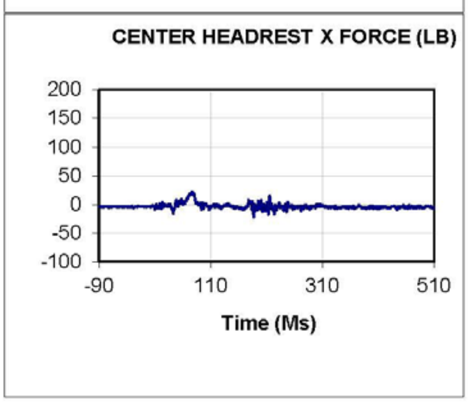
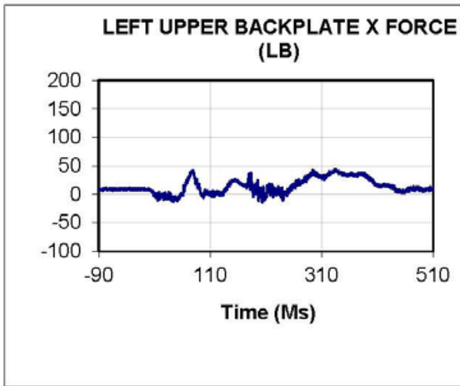

LEFT HEADREST X FORCE (LB)
200
150
100
50
0
-50
-100
-90
110
310
510
Time (Ms)

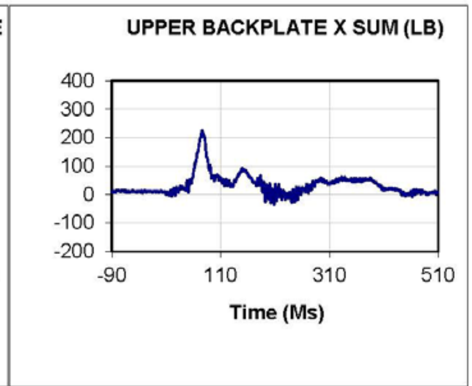

HEADREST X SUM (LB)
400
300
200
100
0
-100
-200
-90
110
310
510
Time (Ms)

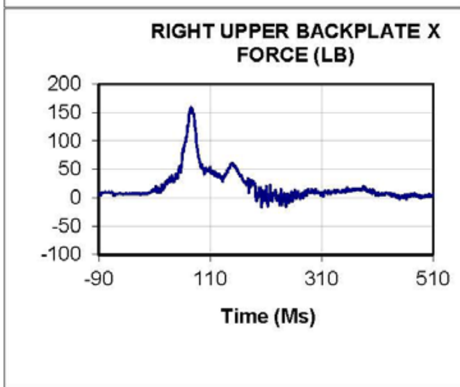

RIGHT HEADREST X FORCE (LB)
200
150
100
50
0
-50
-100
-90
110
310
510
Time (Ms)

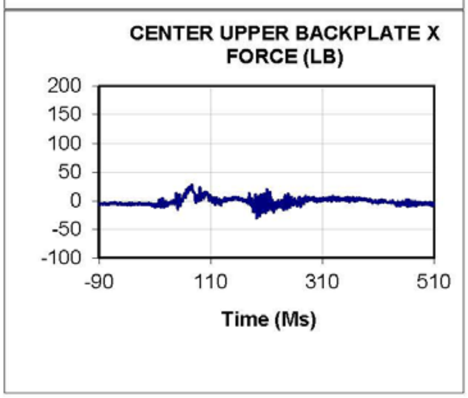

CENTER HEADREST X FORCE (LB)
200
150
100
50
0
-50
-100
-90
110
310
510
Time (Ms)

201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2









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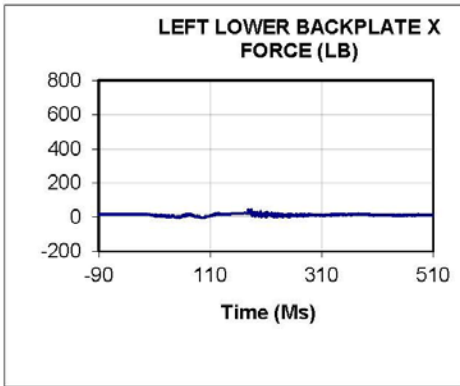
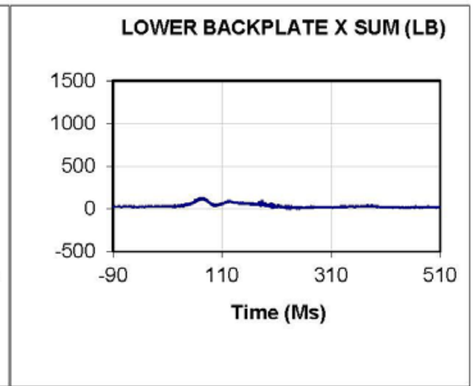
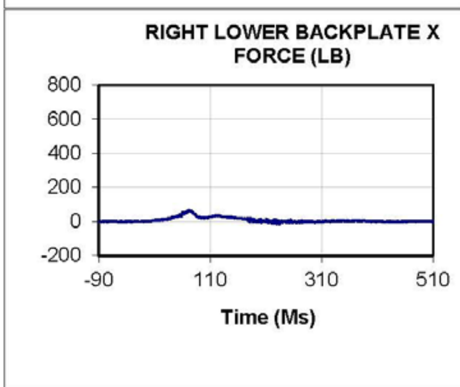
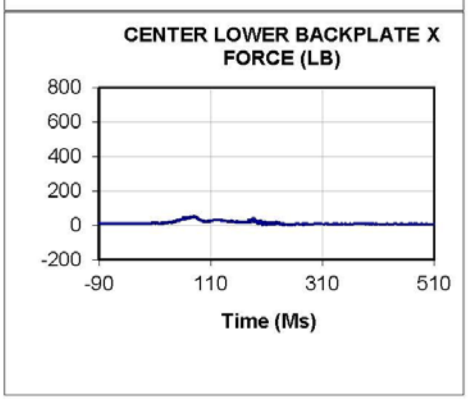
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2









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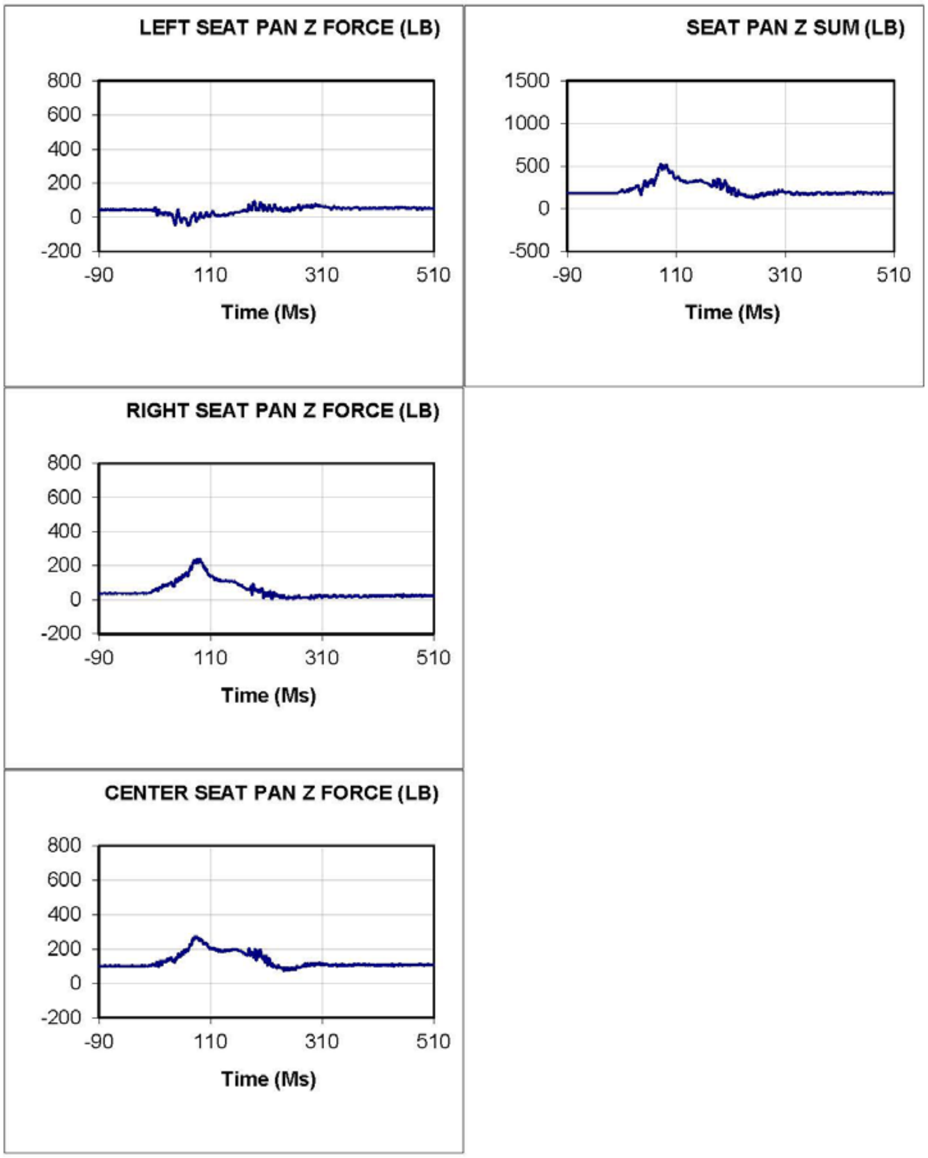
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2



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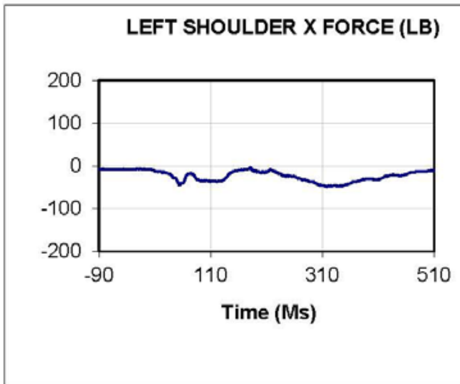

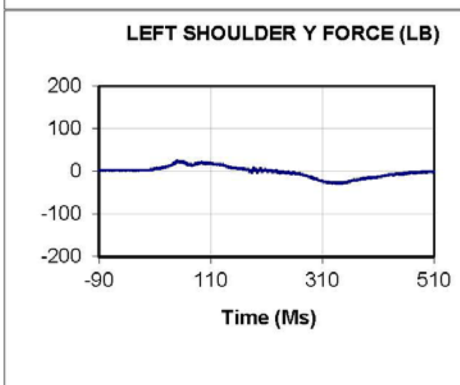

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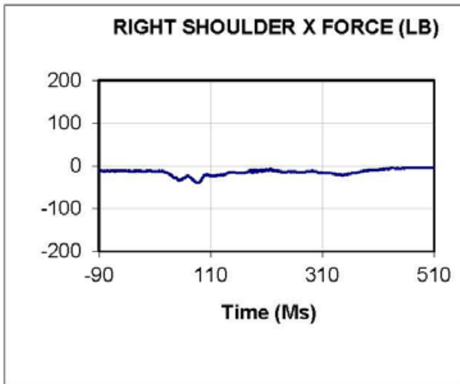

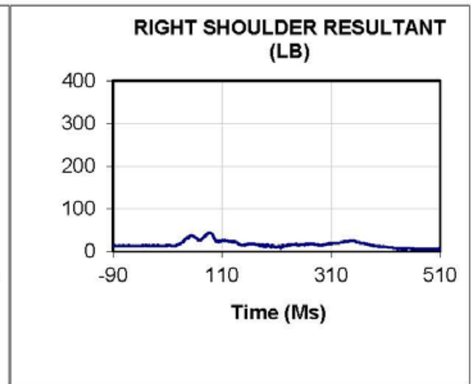

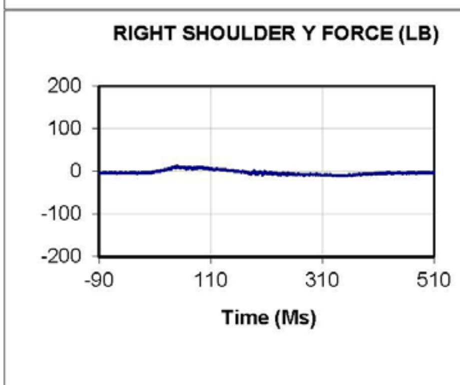

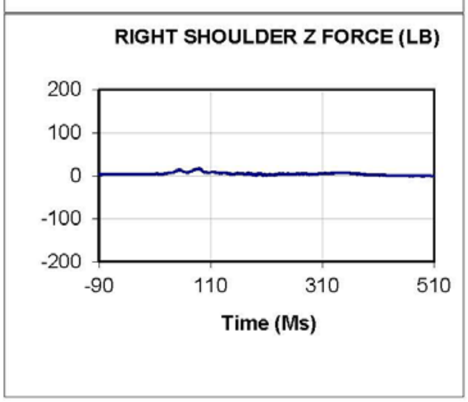

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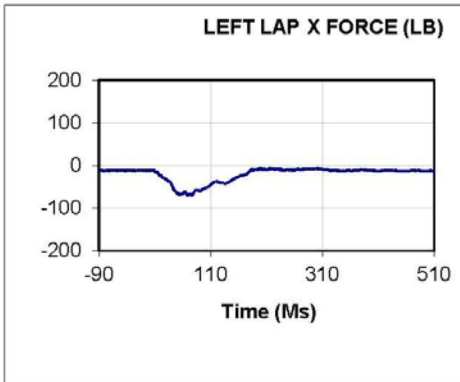

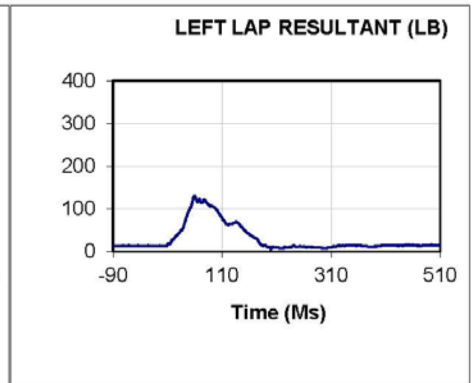

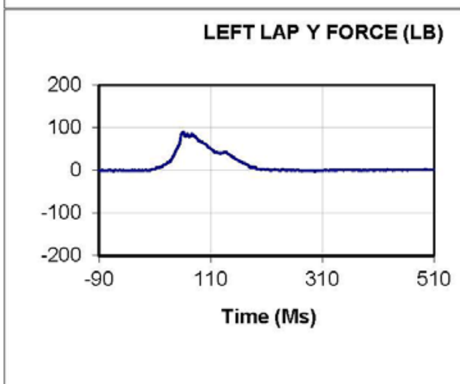

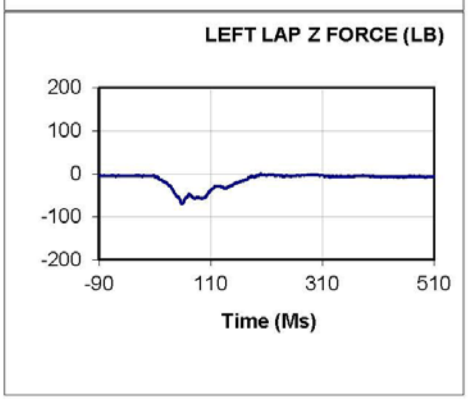

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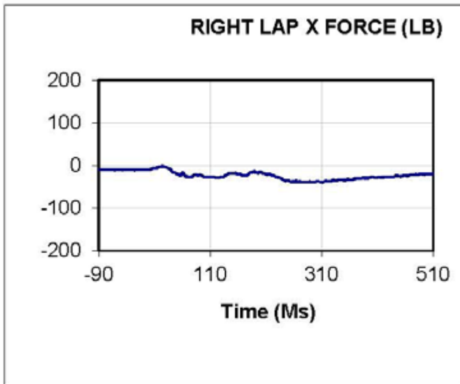
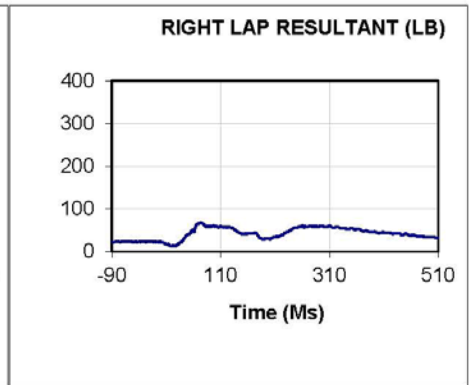
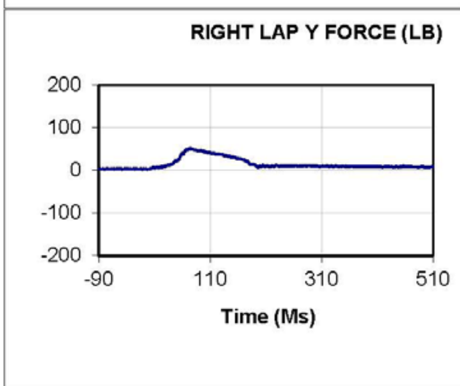
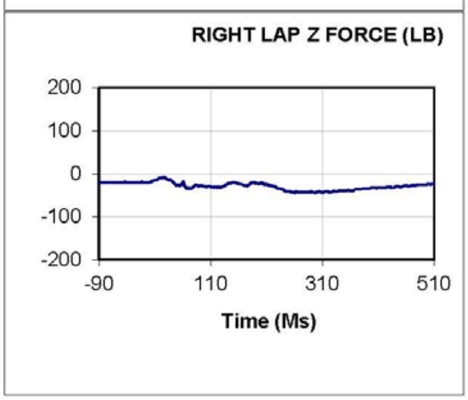
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2









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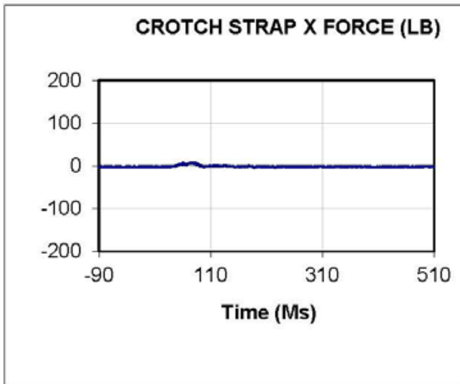

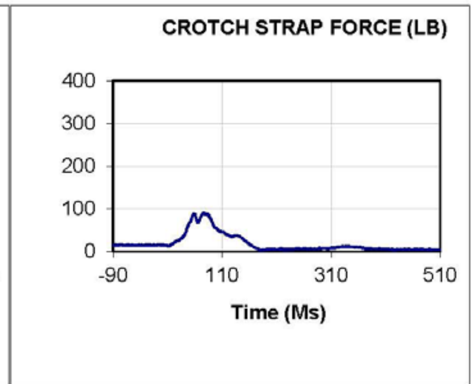

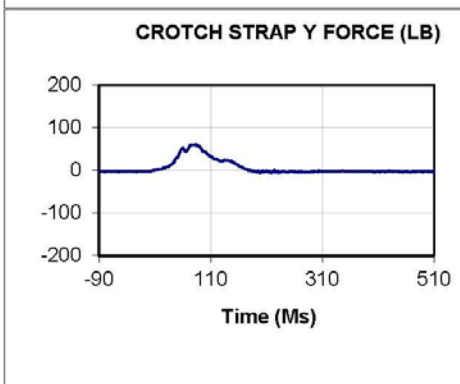

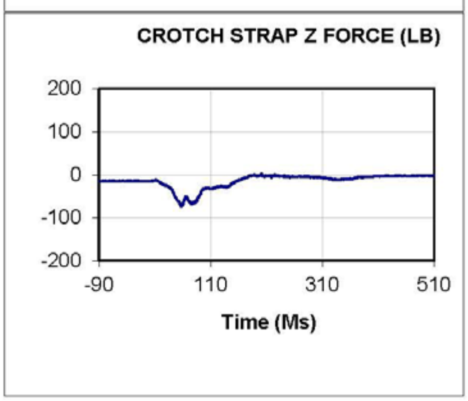

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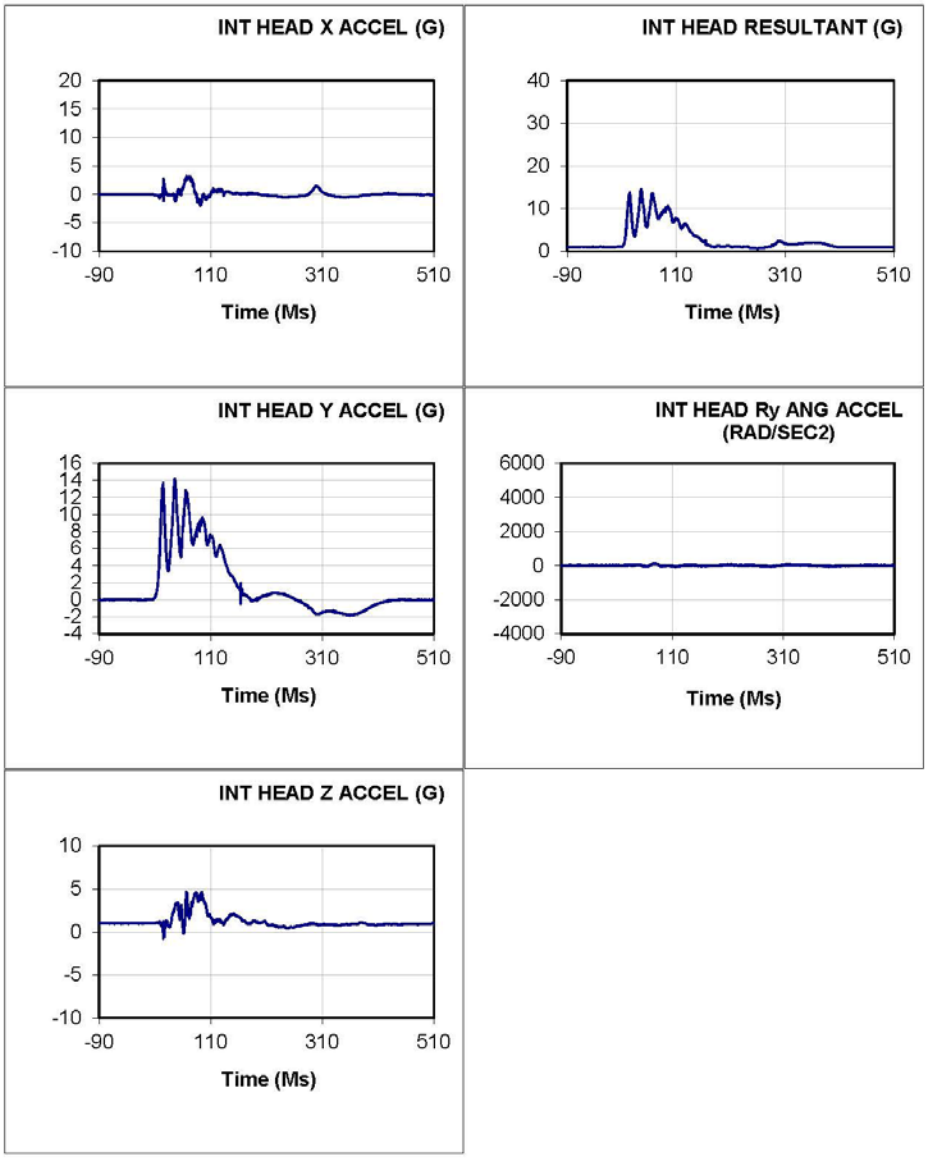

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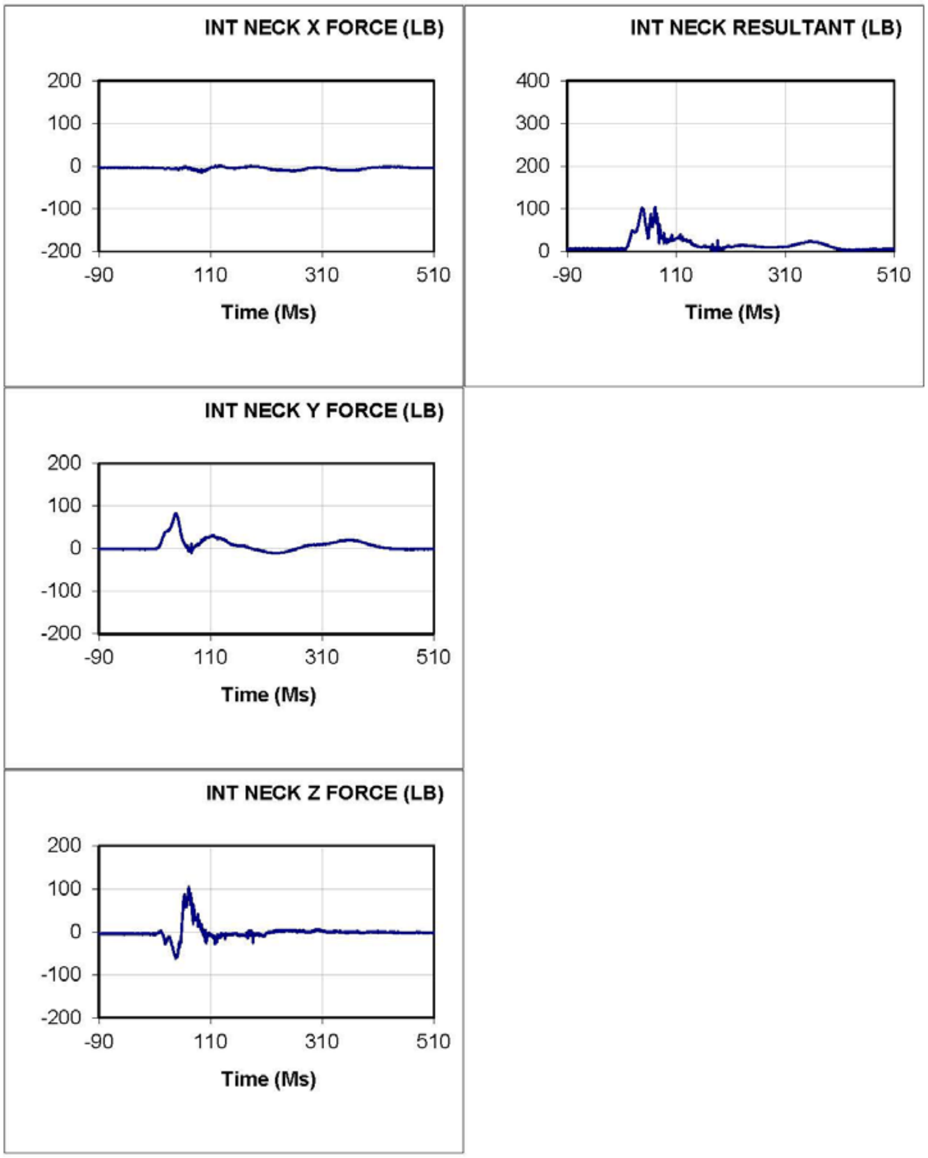
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2



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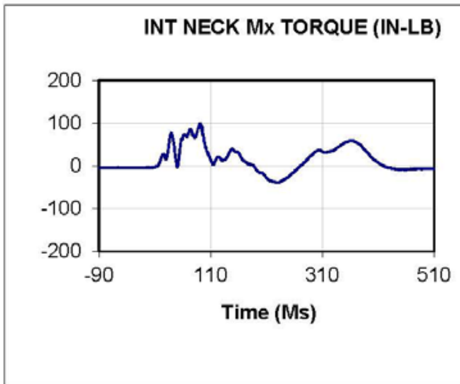

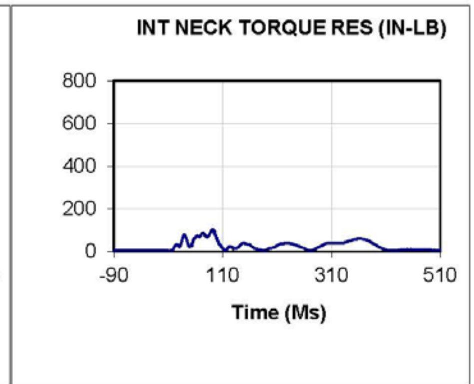

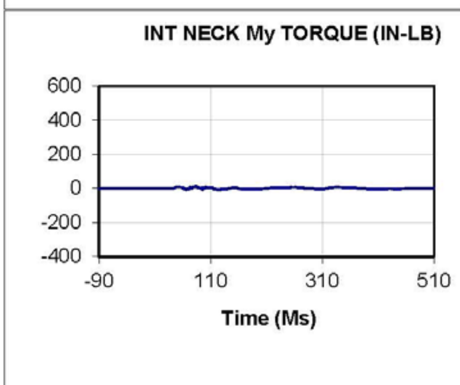

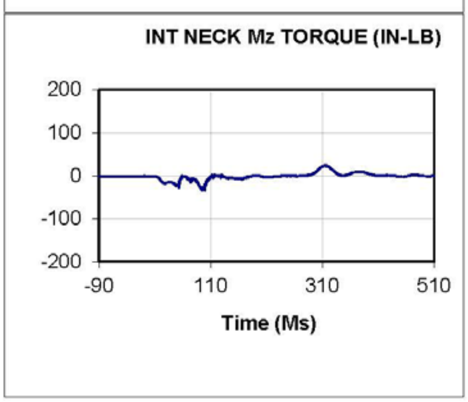

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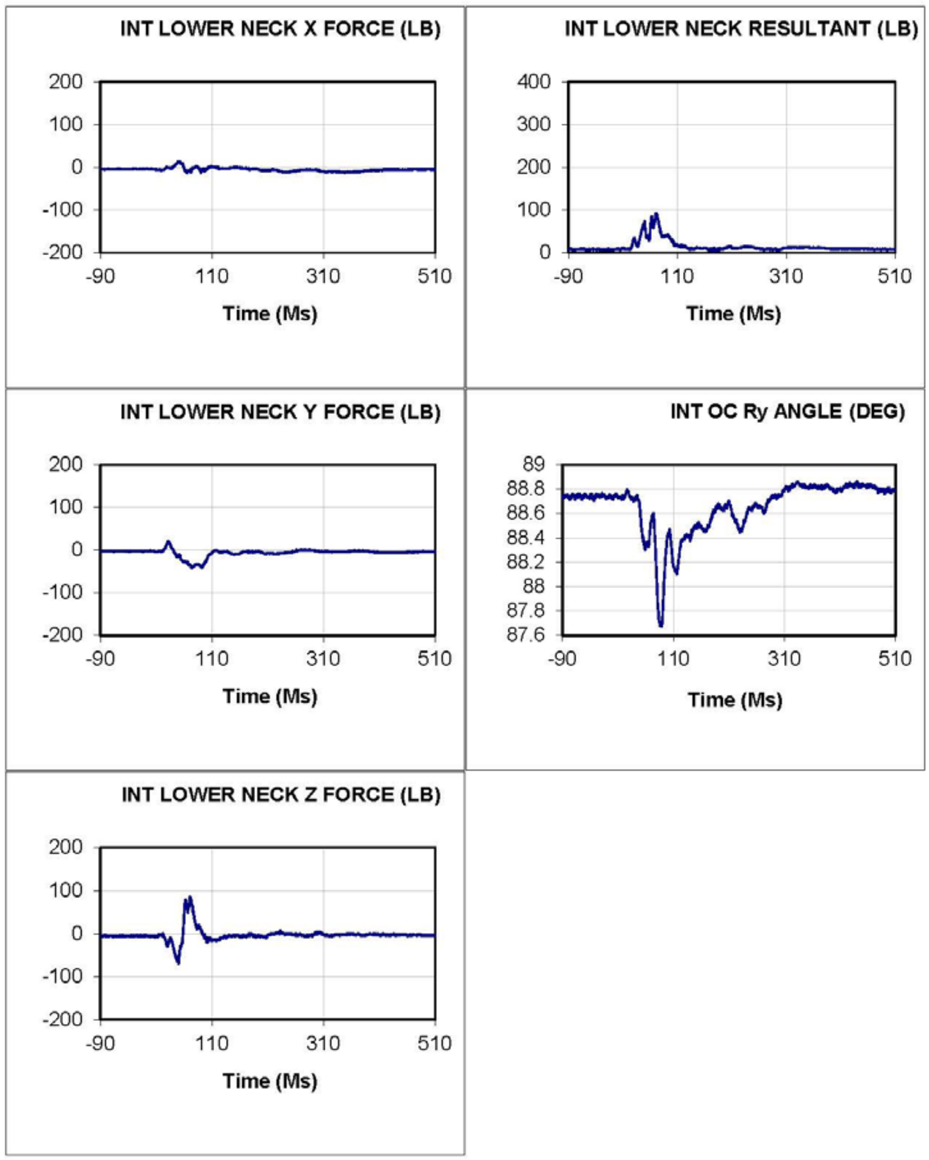

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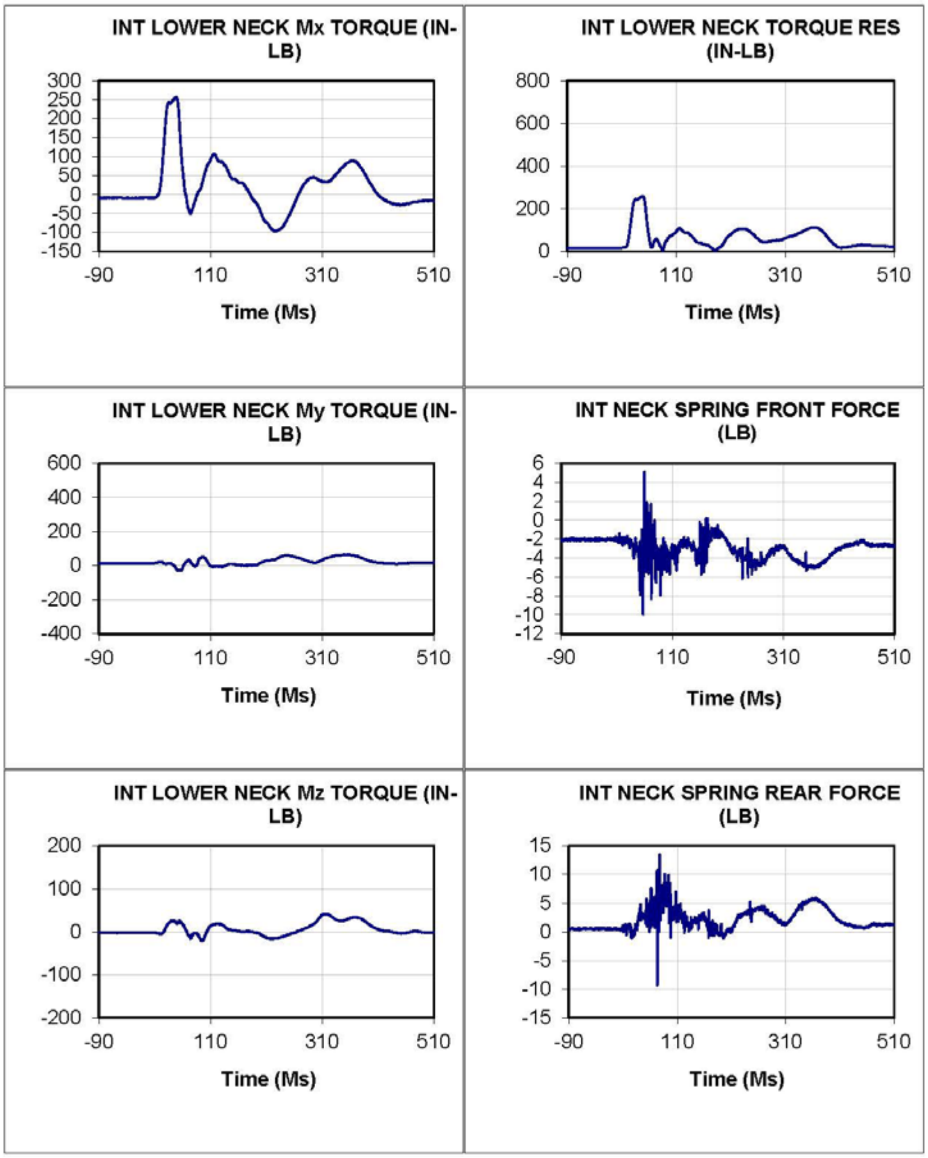
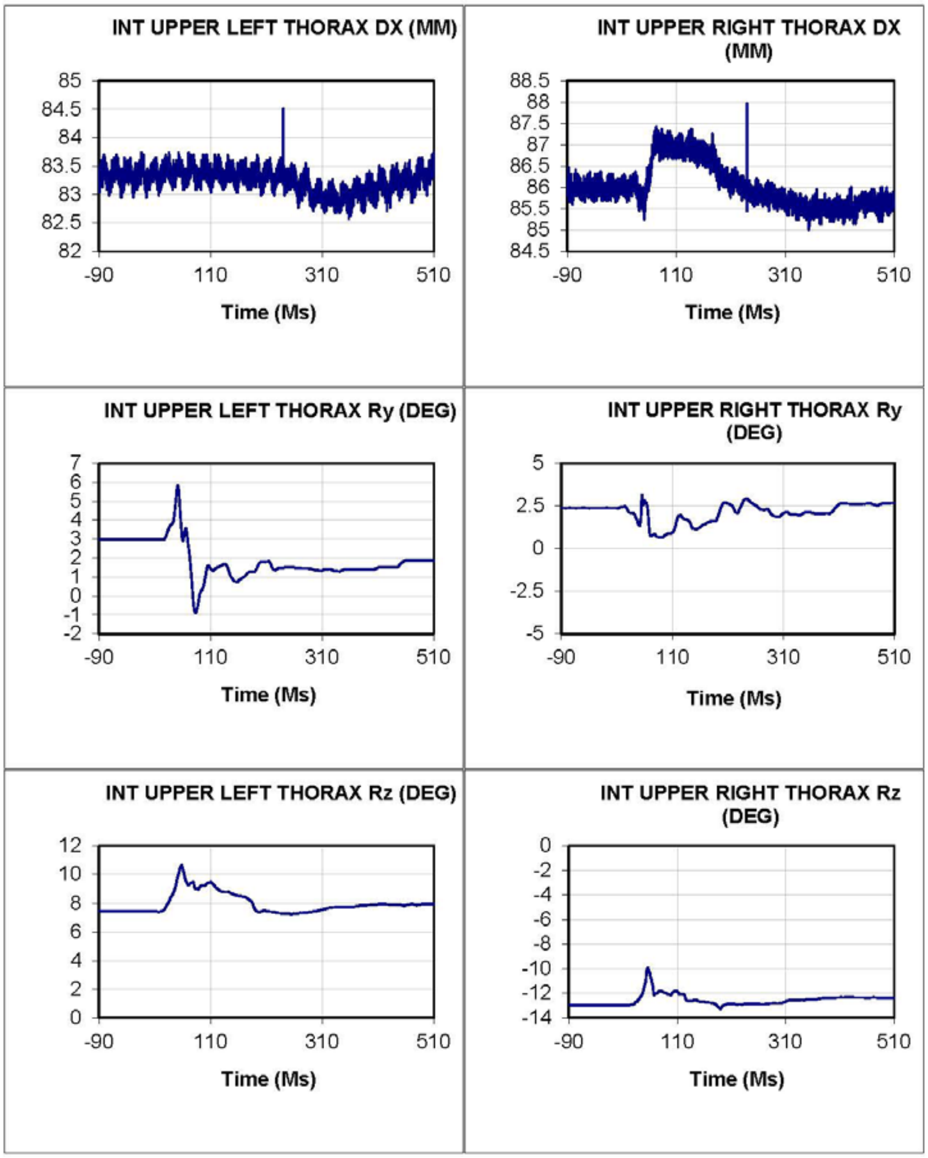

INT LOWER NECK Mx TORQUE (IN-LB)
300
250
200
150
100
50
0
-50
-100
-150
-90
110
310
510
Time (Ms)
INT LOWER NECK TORQUE RES (IN-LB)
800
600
400
200
0
-90
110
310
510
Time (Ms)
INT LOWER NECK My TORQUE (IN-LB)
600
400
200
0
-200
-400
-90
110
310
510
Time (Ms)
INT NECK SPRING FRONT FORCE (LB)
6
4
2
0
-2
-4
-6
-8
-10
-12
-90
110
310
510
Time (Ms)
INT LOWER NECK Mz TORQUE (IN-LB)
200
100
0
-100
-200
-90
110
310
510
Time (Ms)
INT NECK SPRING REAR FORCE (LB)
15
10
5
0
-5
-10
-15
-90
110
310
510
Time (Ms)

201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2



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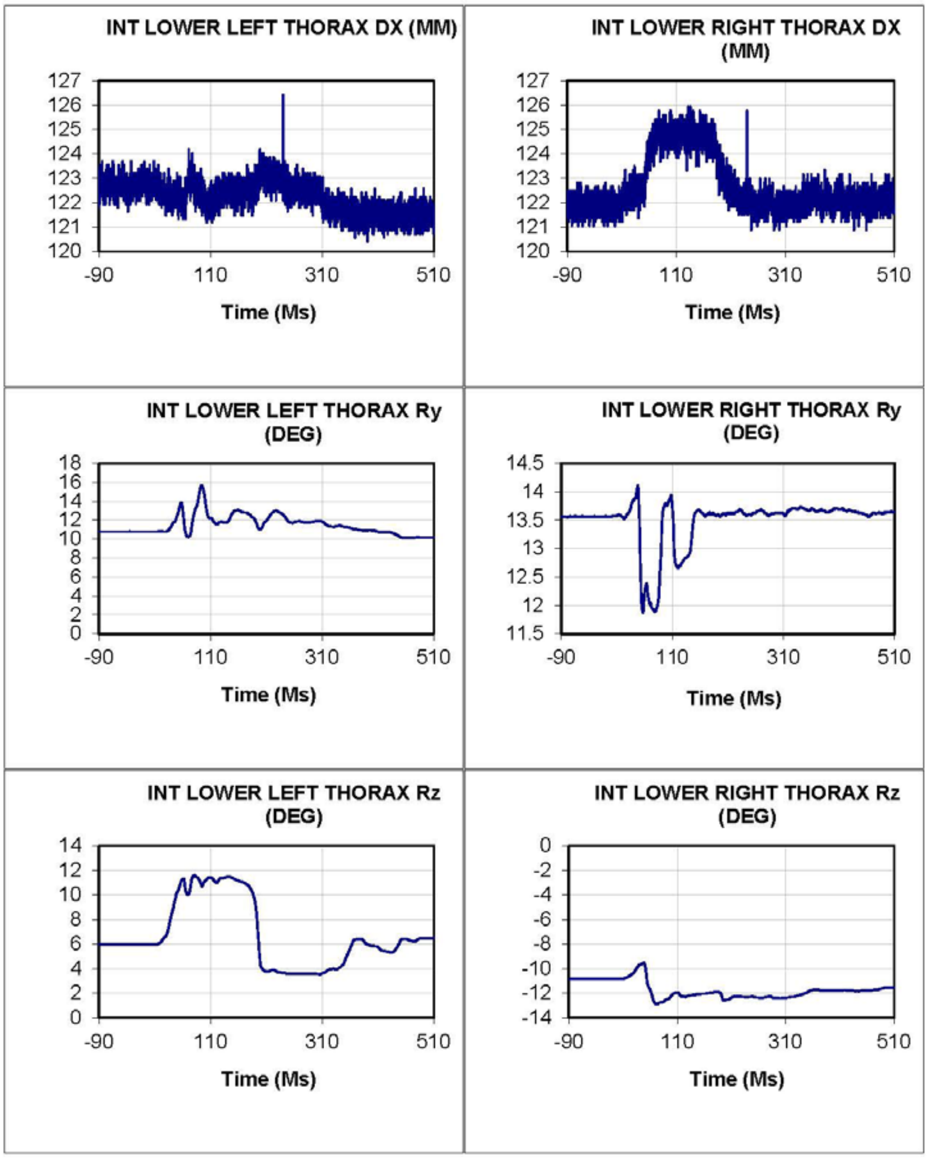
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2



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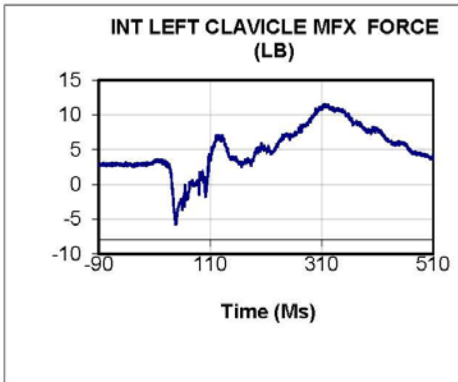
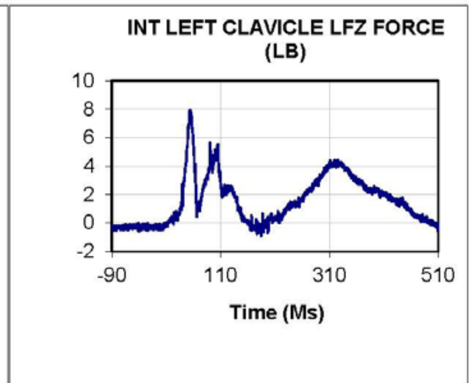
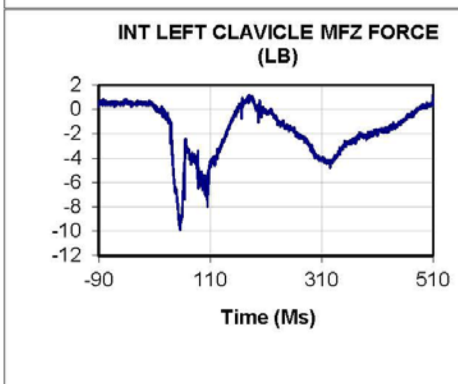
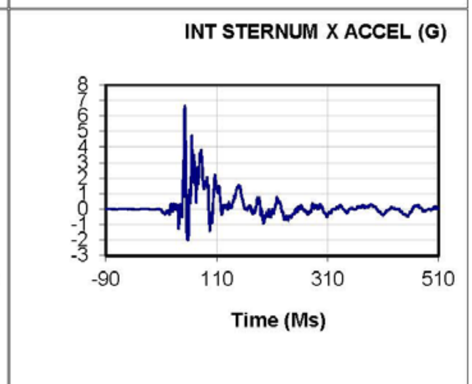
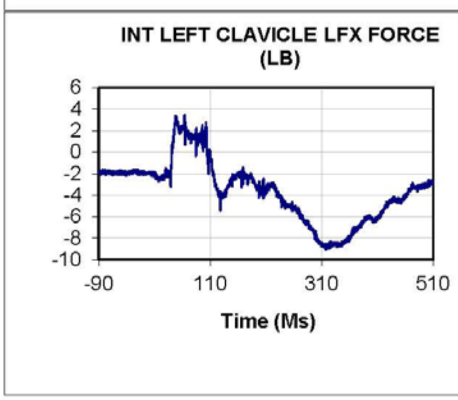
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2











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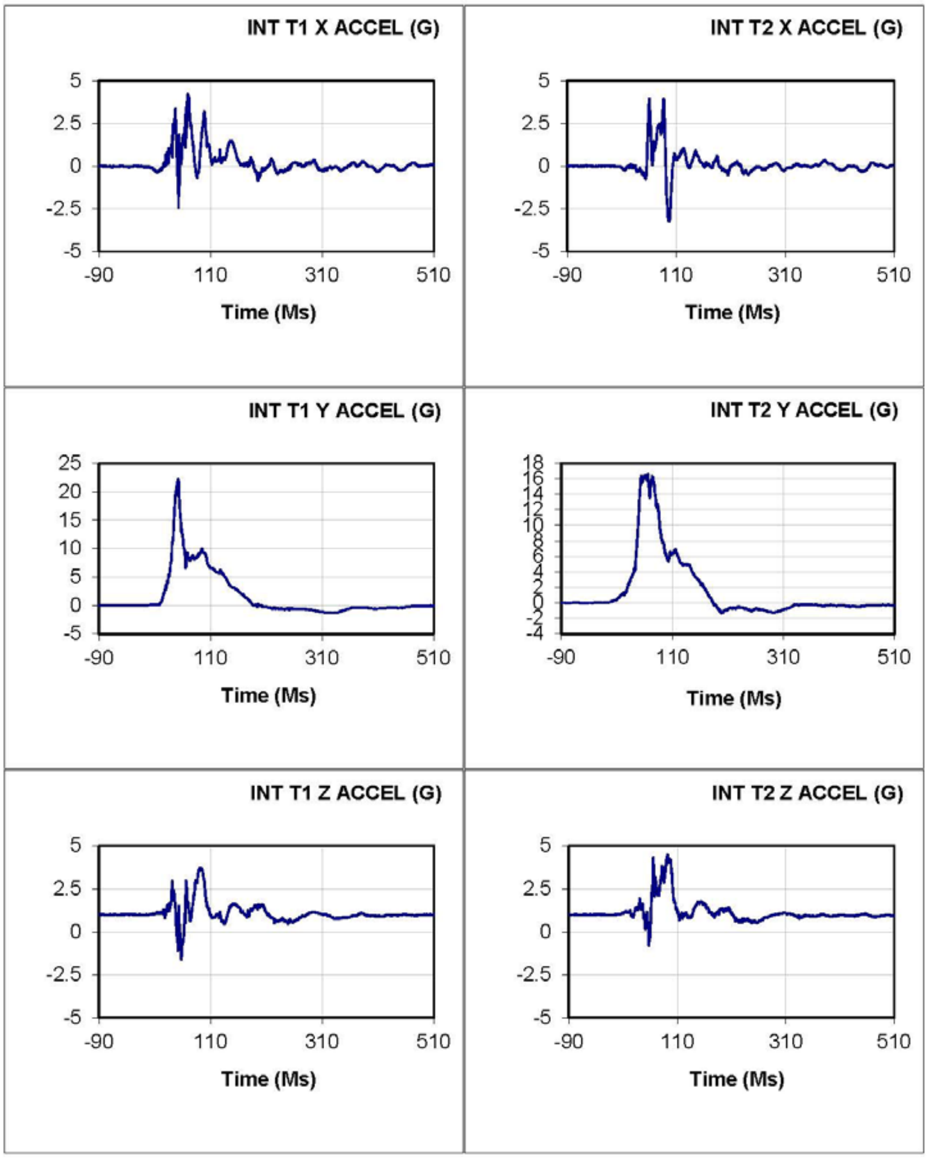
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2



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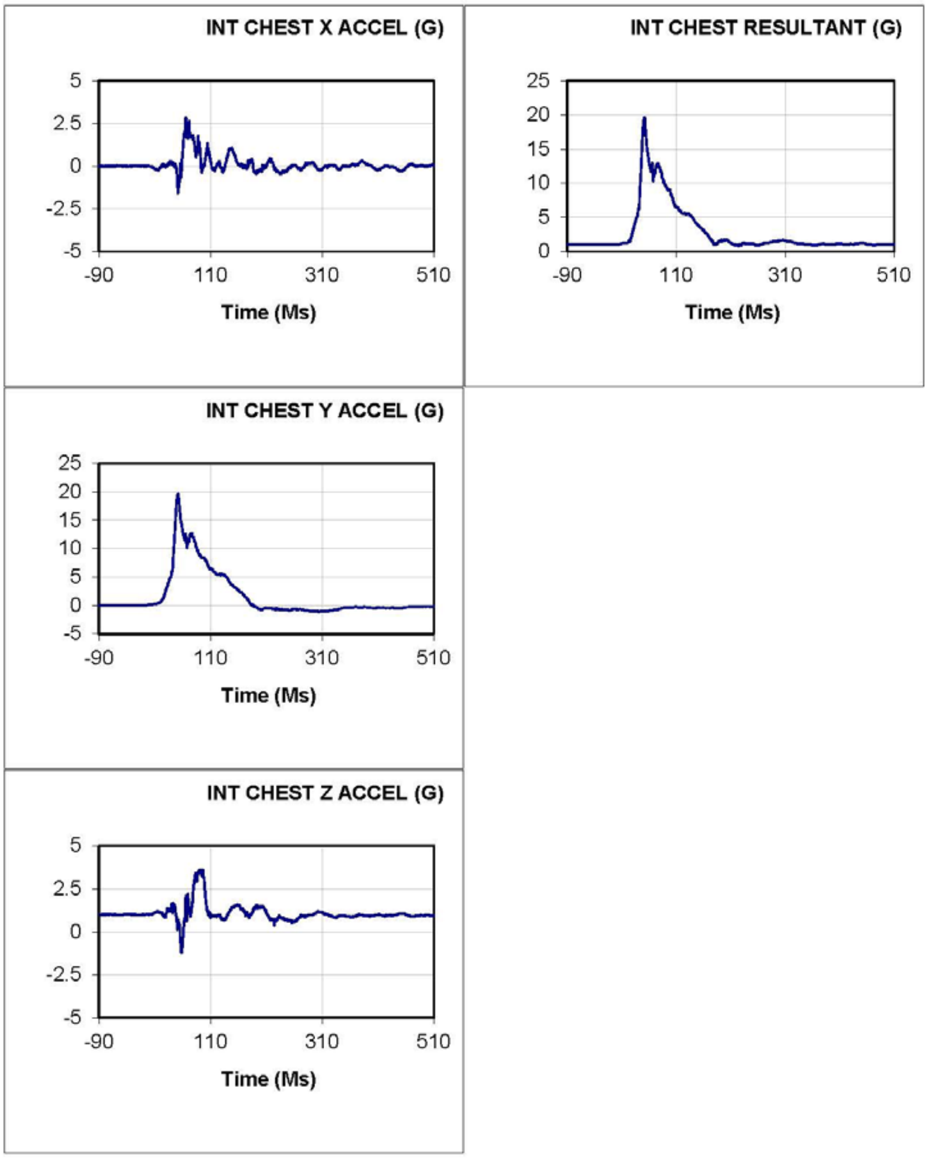
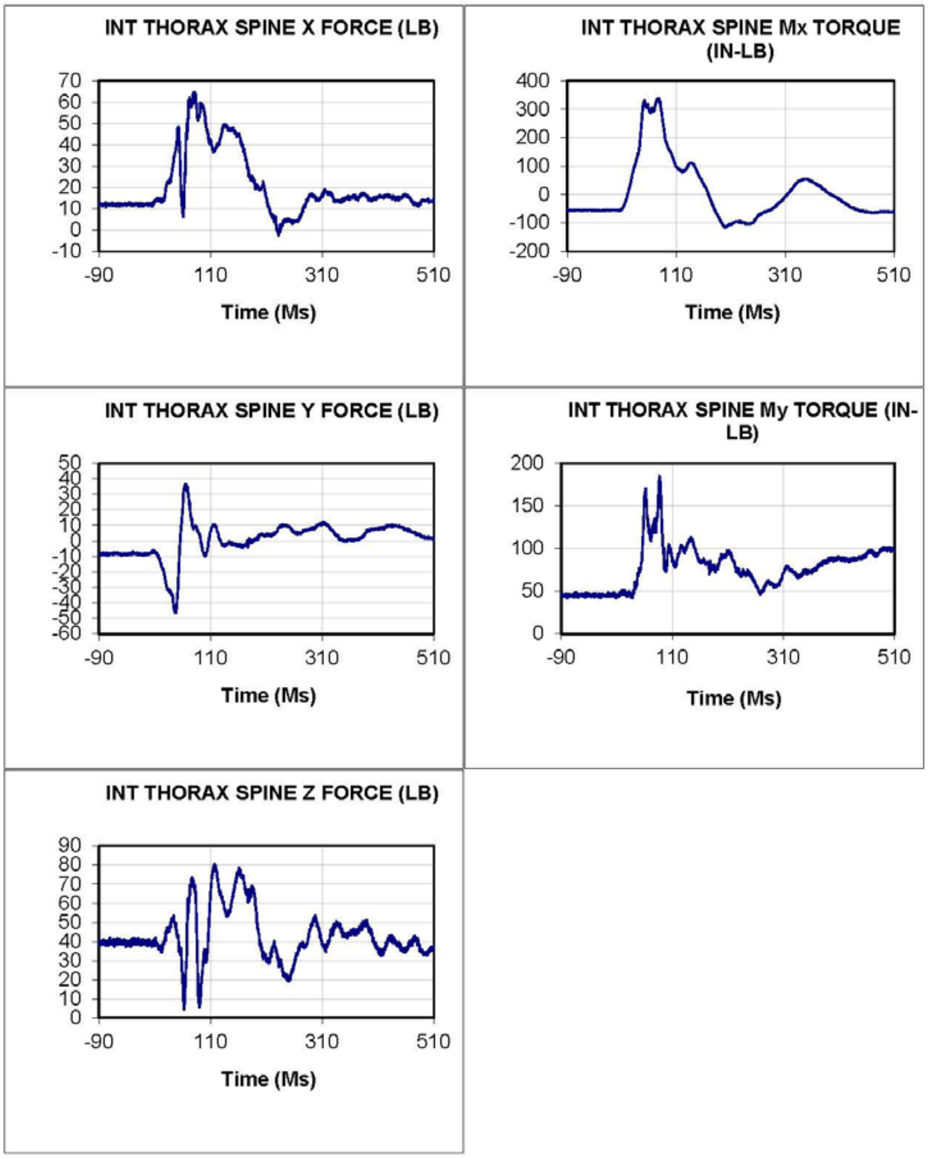
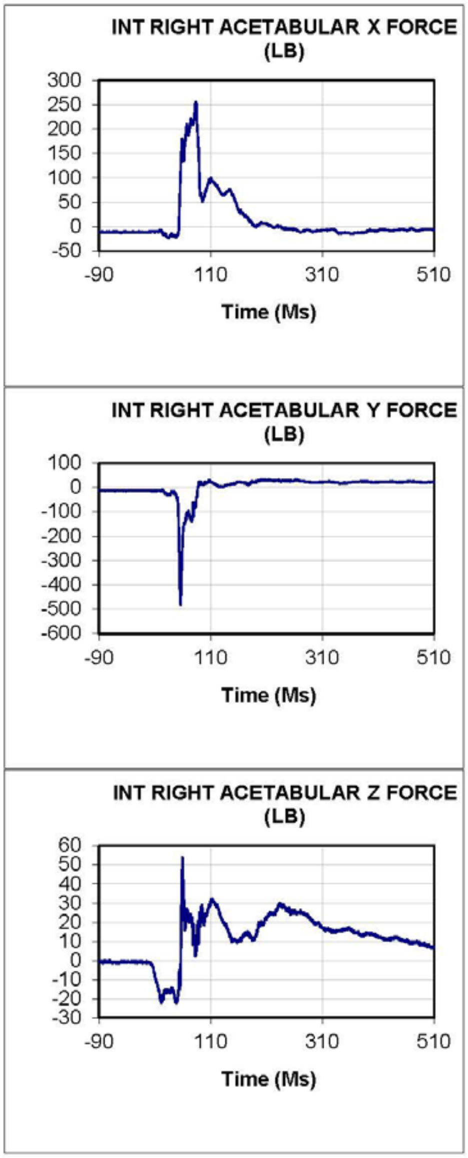
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2



Distribution A: Approved for public release; distribution unlimited.
88 ABW/PA Cleared 02/12/2014; 88ABW-2014-0506.


INT THORAX SPINE X FORCE (LB)
Time (Ms)
INT THORAX SPINE Mx TORQUE (IN-LB)
Time (Ms)
INT THORAX SPINE Y FORCE (LB)
Time (Ms)
INT THORAX SPINE My TORQUE (IN-LB)
Time (Ms)
INT THORAX SPINE Z FORCE (LB)
Time (Ms)

201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2



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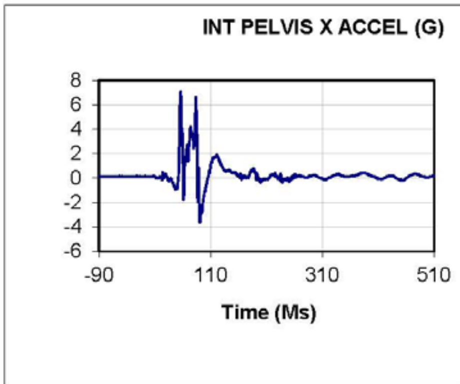
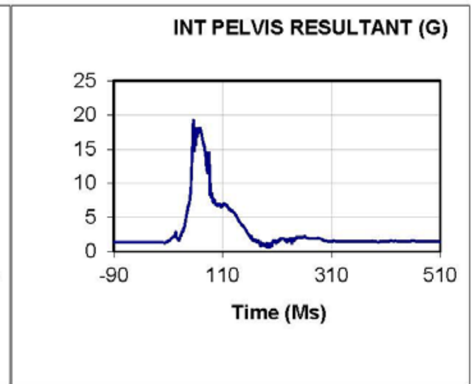
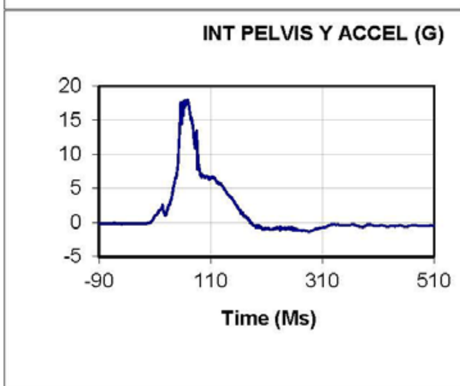
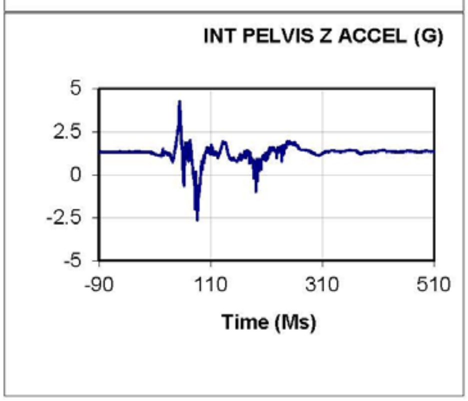
201302 Test: 8694 Test Date: 130131 Subj: THOR Cell: C2









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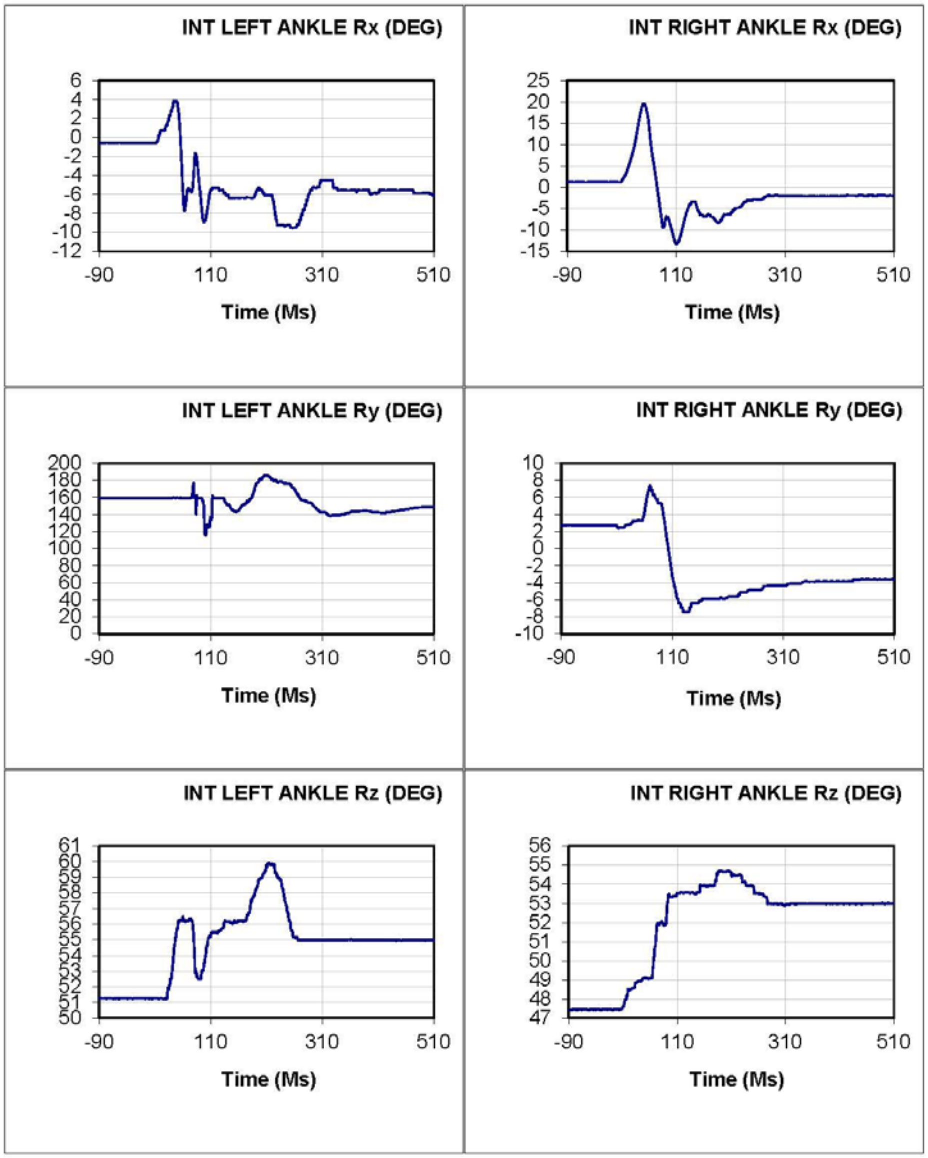
INT LEFT ANKLE Rx (DEG)
Time (Ms)
INT RIGHT ANKLE Rx (DEG)
Time (Ms)
INT LEFT ANKLE Ry (DEG)
Time (Ms)
INT RIGHT ANKLE Ry (DEG)
Time (Ms)
INT LEFT ANKLE Rz (DEG)
Time (Ms)
INT RIGHT ANKLE Rz (DEG)
Time (Ms)
-90
110
310
510